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ABSTRACT

This first semester laboratory manual provides activities for junior high school students which reinforce construction concepts presented in the textbook (VT 014 241) and the accompanying teacher's guide (VT 014 244). Each of the 73 activities includes a stated objective and procedures for carrying out the activity with drawings, charts, and pictures provided when necessary. Sample topics include: (1) Applying Technology to People, (2) Surveying and Mapping, (3) Designing and Engineering Construction Projects, (4) Estimating and Bidding, (5) Building Superstructures, and (6) Building Wood Frames. The manual for the second semester is available as VT 014 243. Other related documents are available as VT 014 088 and VT 014 238-VT 014 240. (GEB)

*Industrial Arts Curriculum Project*

# THE WORLD OF
# Construction

## LABORATORY MANUAL

SEMESTER

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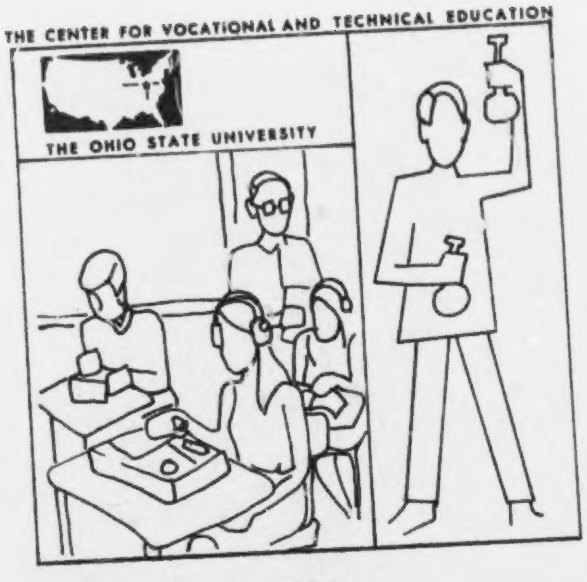
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# THE WORLD OF Construction

## LABORATORY MANUAL

SEMESTER 1

DONALD G. LUX • WILLIS E. RAY, Co-Directors
Industrial Arts Curriculum Project
A. DEAN HAUENSTEIN, Assistant Director
Curriculum Development

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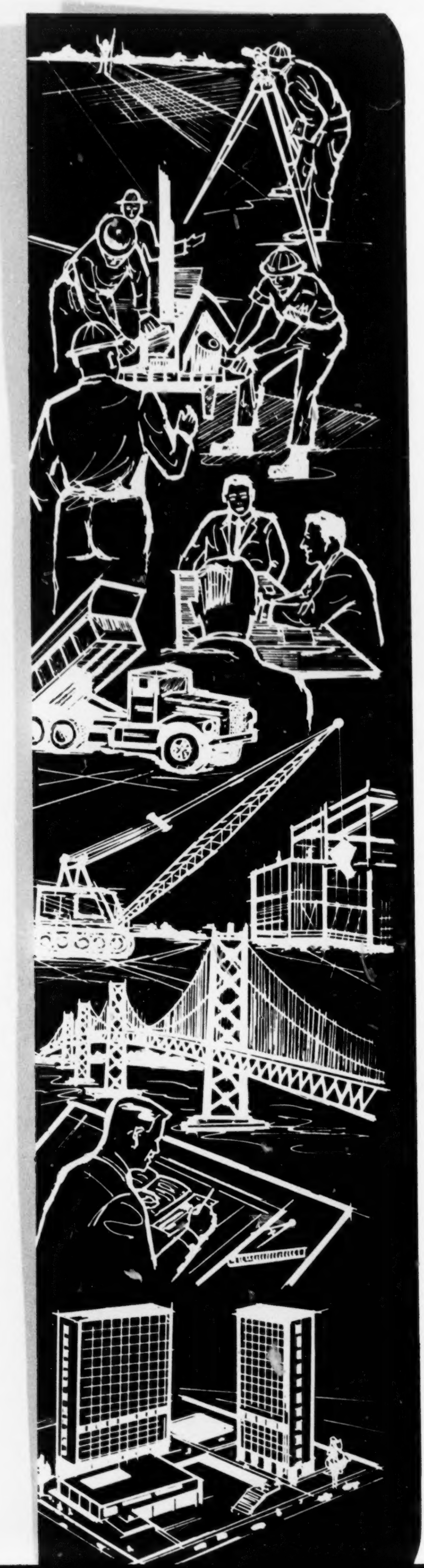

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*The activity numbers are the same as the reading assignment numbers to which they relate. Some readings are not followed by activities, so this listing skips some numbers. Other readings are followed by activities which require more than one day to complete. Each of these activities is identified by a number and a letter.

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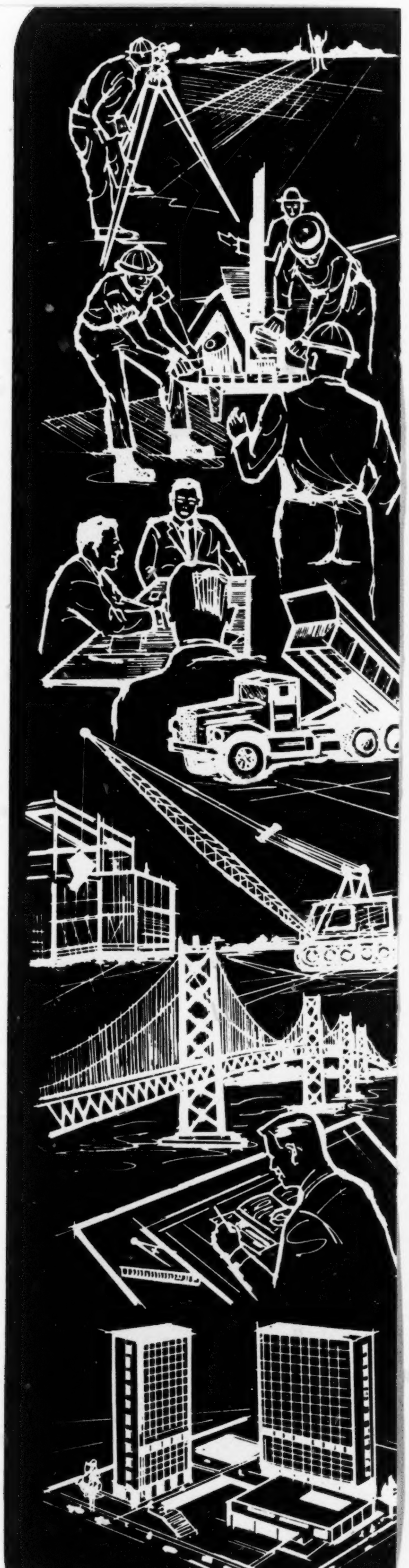


**ACTIVITY 1**

# Man and Technology

Technology changes because men try to find better ways to do things. Your laboratory activity today should help you understand how and why technology changes. You will drill holes with a very old hand tool, a newer hand tool, and a motor-driven tool. You will time each technique and compare drilling times for the three tools. Then you can decide which technique is best, and why.

## Problem

### Objective:

Using a piece of wood, an electric drill, a hand drill, and a bow drill, drill holes correctly and compare efficiency in relation to time and cost of labor per drilled hole.

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | hand drill with $\frac{1}{4}''$ twist drill |
| 1 | bow and drill (approx. $\frac{1}{4}''$) |
| 1 | hand block for bow drill |
| 1 | C clamp |
| 1 | watch with a second hand (from student or wall clock) |
| 1 | portable electric drill with $\frac{1}{4}''$ twist drill |
| 1 | workbench with vise |
| 5 | pr. safety glasses |

**Supplies** (Group of 5)
2 pcs. $\frac{3}{4}''$ board (scrap)

### Drilling Holes

1. **Drilling:** Drill three holes with the bow drill, three holes with the hand drill, and three holes with the electric drill. See Figs. 1-1, 1-2, and 1-3.

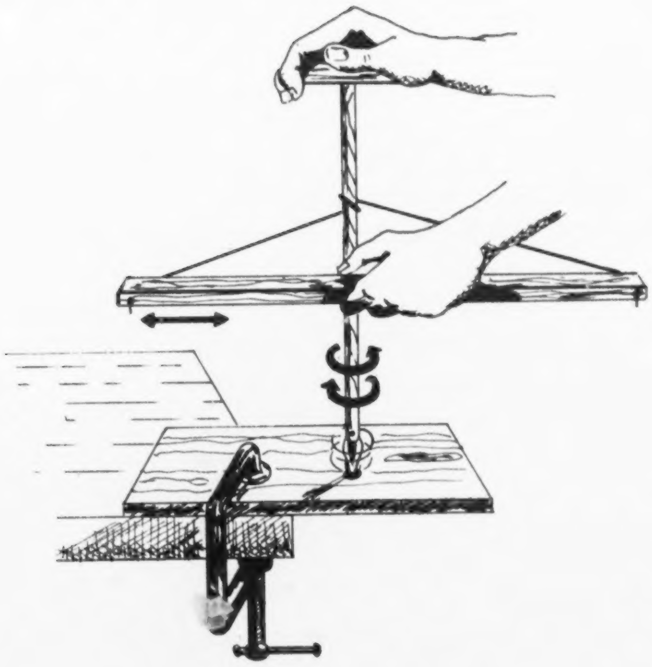


Fig. 1-1. Bow Drill

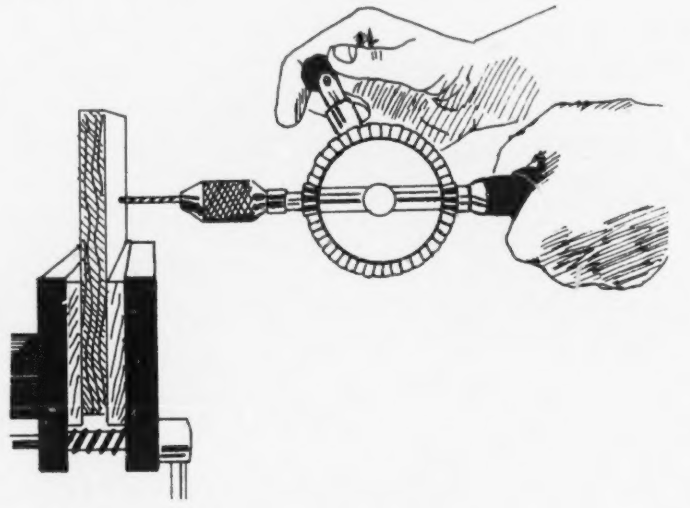


Fig. 1-2. Hand Drill

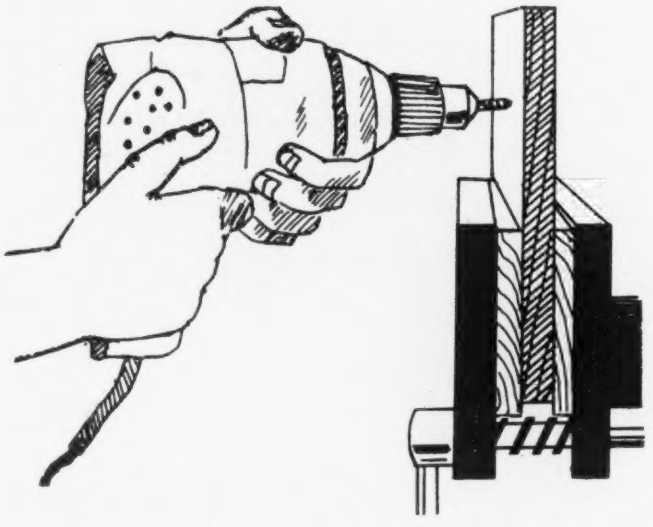


Fig. 1-3. Electric Drill

2. **Timing:** Time the drilling operation for each hole. Timing starts as the drill starts to cut. Timing stops when the drill is through the board.
3. In Fig. 1-4, record the drilling time for making each hole.
4. As a group, find the average drilling time for each technique. (Add the three recorded times and divide the sum by 3.)
5. Write the average times in Fig. 1-4 under the "Avg." column.
6. Put away equipment and supplies.
7. Answer the questions.

## Questions

1. Which drilling technique produced a hole in the shortest *average* time?
2. For each technique, find and record the labor cost per hole. (See Fig. 1-5.) Which technique produced a hole at the lowest cost?
3. Which technique costs the most in labor?
4. One way to measure the efficiency of a tool or machine is to find the labor cost per *unit* of work. For example, find the cost for *one* drilled hole. If you measure efficiency this way, which drilling technique was most efficient?

Fig. 1-5. Drilling Time and Labor Costs

| Drilling Time (one hole) | Labor Cost (one hole) |
|---|---|
| 1 — 5 sec. | ½¢ |
| 6 — 10 sec. | 1¢ |
| 11 — 15 sec. | 1½¢ |
| 16 — 20 sec. | 2¢ |
| 21 — 25 sec. | 2½¢ |
| 26 — 30 sec. | 3¢ |
| 31 — 35 sec. | 3½¢ |
| 36 — 40 sec. | 4¢ |
| 41 — 45 sec. | 4½¢ |
| 46 — 50 sec. | 5¢ |
| 51 — 55 sec. | 5½¢ |
| 56 — 60 sec. | 6¢ |
| 1 — 2 min. | 12¢ |
| 2 — 3 min. | 18¢ |
| over — 3 min. | 30¢ |

Fig. 1-4. Time and Cost for Three Drilling Techniques

| | Time to Drill Holes | | | | Labor Cost Per Hole (from Fig. 1–5) |
|---|---|---|---|---|---|
| Technique | #1 | #2 | #3 | Avg. | |
| Bow drill | | | | | ¢ |
| Hand drill | | | | | ¢ |
| Electric drill | | | | | ¢ |

**ACTIVITY 3**

# Applying Technology to People

Today you will be assigned to a group. Each group will select a foreman, timekeeper, recorder, safety and grievance man, and equipment supervisor. Follow your teacher's directions.

## Problem 1

### Objective:

Given the organization shown in Fig. 3-1, organize student groups for efficient classroom operation.

### Organizing the Class

1. Read the following job responsibilities. Within your group select a student for each position. See Fig. 3-1.

   **Timekeeper:** Tells the group how much time is set up for different jobs; gets jobs started on time; warns the group when it is time to clean up the area and put away materials.

   **Foreman:** Supervises the work assignments and quality of work for his group.

   **Recorder:** Reports absent or tardy students to the teacher each day; keeps recorded data for the group.

   **Safety and Grievance Man:** Keeps a check on safe working conditions and sees that safety precautions are followed. Receives all complaints from the group and helps decide whether or not to relay the information to the teacher. He also tries to improve working conditions for his group.

   **Equipment Supervisor:** Passes out, collects, and stores his group's Laboratory Manuals and other materials.

2. Each student should record the personnel assignments for his group in Fig. 3-2.
3. The recorder should enter the names of the students in his group and their job titles on the teacher's Class Organization Chart.

## Problem 2

### Objective:

Given a Laboratory Manual and a felt pen in an assigned color, code the Laboratory Manual for easy identification, distribution, and collection.

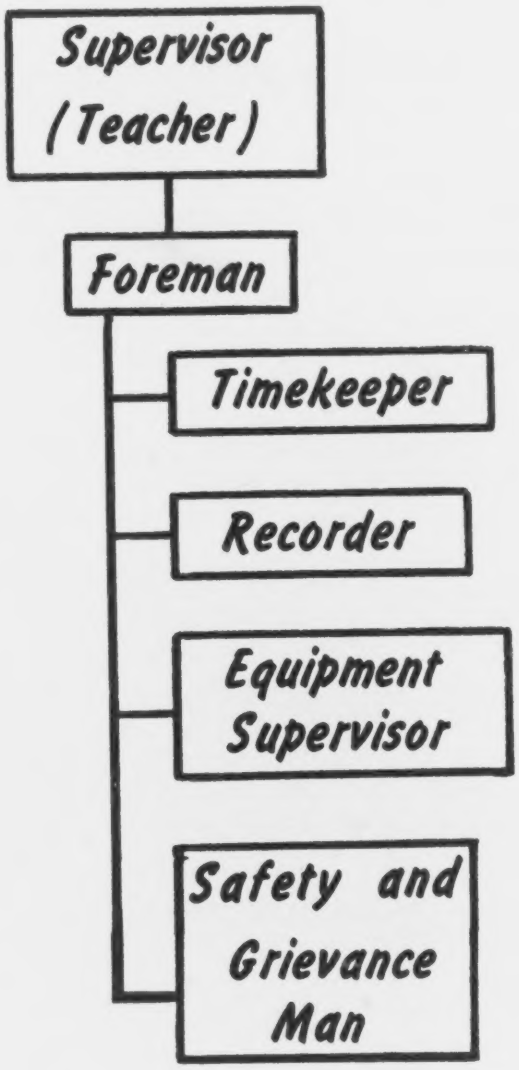


Fig. 3-1. Group Organization

## Coding and Storing

1. Code the Laboratory Manual according to the teacher's directions. See Fig. 3-3.
2. The equipment supervisor should collect and store his group's Laboratory Manuals as directed by the teacher.

Fig. 3-2. Personnel Assignments

Period__________ Workstation__________

Group No.__________

Foreman ____________________

Timekeeper____________________

Recorder____________________

Equipment Supervisor ____________________

____________________

Safety and Grievance Man ____________________

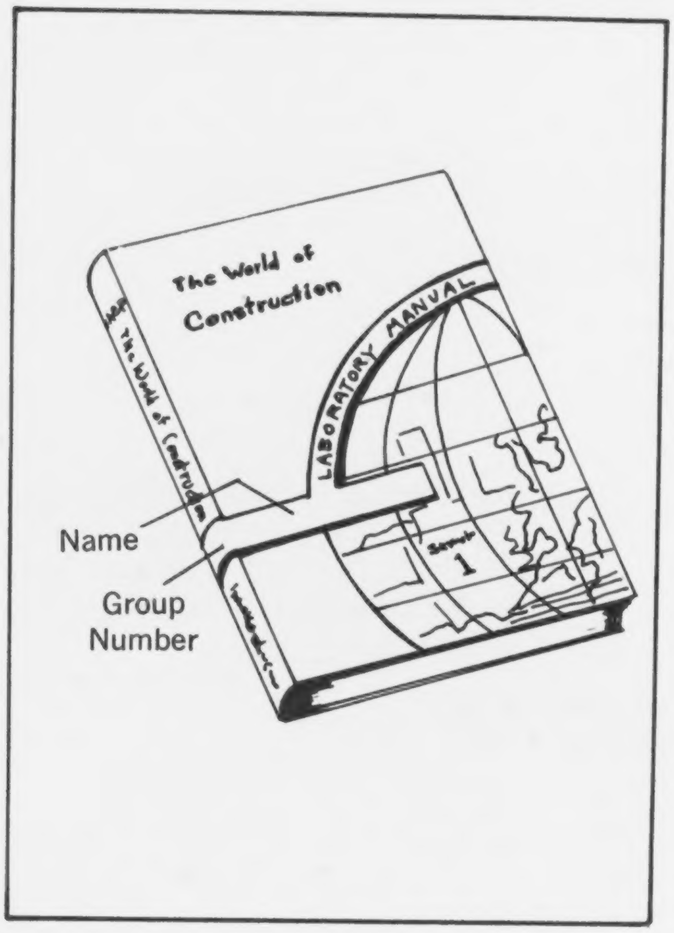

The World of Construction
LABORATORY MANUAL
The World of Construction
1
Name
Group Number

Fig. 3-3. Laboratory Manual

**ACTIVITY 4**

# Managing Construction

Today you will play a game similar to Bingo; but instead of using numbers, you will use concepts related to management, personnel, processing, and structures.

**Problem**

## Objective:

Using the word game called "Build," answer questions about the concepts used in the game.

## Playing "Build"

1. Select five words from each column under *B*. See Fig. 4-1. Write these in the blanks under *B* in Fig. 4-2.
2. Do the same for columns *U*, *I*, *L*, and *D*.
3. Follow the teacher's directions for playing the game.
4. If time allows, repeat steps 1 and 2 using Fig. 4-3.

| B | U | I | L | D |
|---|---|---|---|---|
| Highway | Tower | Monitoring | Substructure | Superstructure |
| Tunnel | Dam | Researching | Designing | Structuring |
| Directing | Bridge | Processing | Management | Grievance |
| Structure | Organizing | Skyscraper | Economy | Manufacturing |
| Planning | Architect | Employer | Supplying | Construction |
| Correcting | Formulating | Controlling | Initiator | Personnel |
| Engineer | Reporting | Tradesman | Servicing | Technology |
| Industry | Contractor | Demolishing | Directing | Engineering |

Fig. 4-1. Words

| B | U | I | L | D |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |
|  |  | free |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Fig. 4-2. Game Board

| B | U | I | L | D |
|---|---|---|---|---|
|  |  |  |  |  |
|  |  |  |  |  |
|  |  | free |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Fig. 4-3. Game Board

ACTIVITY 5

# Beginning the Project

Today you will find some problems in your community, suggest solutions, select one project, and develop publicity for the project.

## Problem 1

### Objective:

Using a list of community problems and possible solutions and acting as a professional consultant, find one basic problem in your community and suggest a solution.

### Identifying the Problem

1. You will work in one of five groups. Each group will be asked to study one of the community problem areas shown in Fig. 5-1: (1) Shelter, (2) Health, (3) Education, (4) Recreation, or (5) Transportation and Access.
2. Your group is to choose the one community problem, in one area, that you think is most serious. Discuss the selection within your group.

### Recommending a Solution

3. Keep in mind that some kinds of construction projects are paid for and operated by private business, either to make money or because the law requires it. Your city government would finance and operate other kinds of projects.
4. The recorder in your group should write the problem and solution you propose on a sheet of paper. The foreman of each group should prepare to explain the problem and its solution.

## Problem 2

### Objective:

Given five major community problems with suggested solutions and acting as a city planning commission, the class will select one project for public support and develop the publicity for the project.

### Selecting the Project

1. As a city planning commission (class) you are to examine the major problems in your community. Each foreman should explain one problem and a proposed solution to the city planning commission.
2. After the commission (class) has heard all the problems and suggested solutions, members should discuss the pros and cons of each problem and its solution.
3. Select, by vote, the one project you think should be undertaken.

### Publicizing the Project

4. As a city planning commission, discuss how you are going to publicize the need for this project and what the publicity will say. The teacher or the recorder will write the commission's ideas on the chalkboard.

Fig. 5-1. Community Problems and Solutions

| Problems | Suggested Solutions<br>If you do not agree with the suggested solution, supply your own. |
|---|---|
| **1. Shelter** | **1. Shelter** |
| a. City has slums or ghettos. | a. Apartment complex |
| b. Living conditions are crowded. | b. Housing subdivision |
| c. People are moving away from the city. | c. Urban renewal project |
| d. Business areas are overcrowded. | d. Convention center |
| e. There is no community assembly hall. | |
| f. Other__________________ | e. Other__________________ |
| **2. Health** | **2. Health** |
| a. Local sewage pollutes lake or river. | a. City builds sewage treatment plant. |
| b. Local industrial waste pollutes lake or river. | b. Industrialist puts in waste treatment machinery at his plant or mine. |
| c. Another city's sewage or industrial waste pollutes lake or river. | c. Make the other city or industry stop polluting the water. OR, build water purifying plant in your city. |
| d. Odor from garbage dump hangs over city. | d. Build plant to turn garbage into useful fertilizer or to burn it. |
| e. Fumes, smoke, or dust from industrial plant hang over city. | e. Industrialist puts in air cleaning machinery at his plant. |
| f. Other__________________ | f. Other__________________ |
| **3. Education** | **3. Education** |
| a. Elementary schools are overcrowded. | a. New elementary schools |
| b. High schools are overcrowded. | b. New high schools |
| c. City lacks facilities for education following high school. | c. New college or technical schools |
| d. Children must be bussed great distances to school. | d. Boarding schools |
| e. Young children must cross many busy streets going to school. | e. Tunnels or overpasses |
| f. Other__________________ | f. Other__________________ |
| **4. Recreation** | **4. Recreation** |
| a. City is located in fringe TV areas. | a. TV station or coaxial cable |
| b. City lacks daytime entertainment facilities. | b. Amusement park |
| c. City lacks evening entertainment facilities. | c. Drive-in theater |
| d. Crowds can't see sporting events. | d. Sports arena |
| e. City lacks summer or winter outdoor sport facilities. | e. Community swimming pool |
| f. Children play in streets. | f. Community playground |
| | g. Community park and zoo |
| g. Other__________________ | h. Other__________________ |
| **5. Transportation and Access** | **5. Transportation and Access** |
| a. Streets are overcrowded at rush hours. | a. Limited access highway or freeway |
| b. Bridges and underpasses are bottlenecks. | b. Bridge |
| c. There is no local air transport service. | c. Airport |
| d. City lacks neighborhood stores. | d. Tunnels |
| e. Stores lack adequate parking. | e. Shopping center |
| f. Young children must cross busy highway to get to school. | f. Parking lot |
| g. Other__________________ | g. Other__________________ |

**ACTIVITY 6**

# Selecting a Site

**Problem 1**

## Objective:

Given (1) a picture of possible construction sites in a community, (2) a selected project to build (from Activity 5), and (3) a table of site feasibility factors:

a. Find the available sites on Fig. 6-1.
b. Decide the feasibility of each site as a possible construction site for your project.
c. Select a site for the project.

## Determining Site Feasibility

1. On Fig. 6-1 locate the six possible construction sites.
2. In Fig. 6-2 complete the information for each site.
3. Study the completed information in Fig. 6-2 and discuss the feasibility of each site in relation to your selected construction project.

## Selecting a Site

4. As a class, select a site for the project.

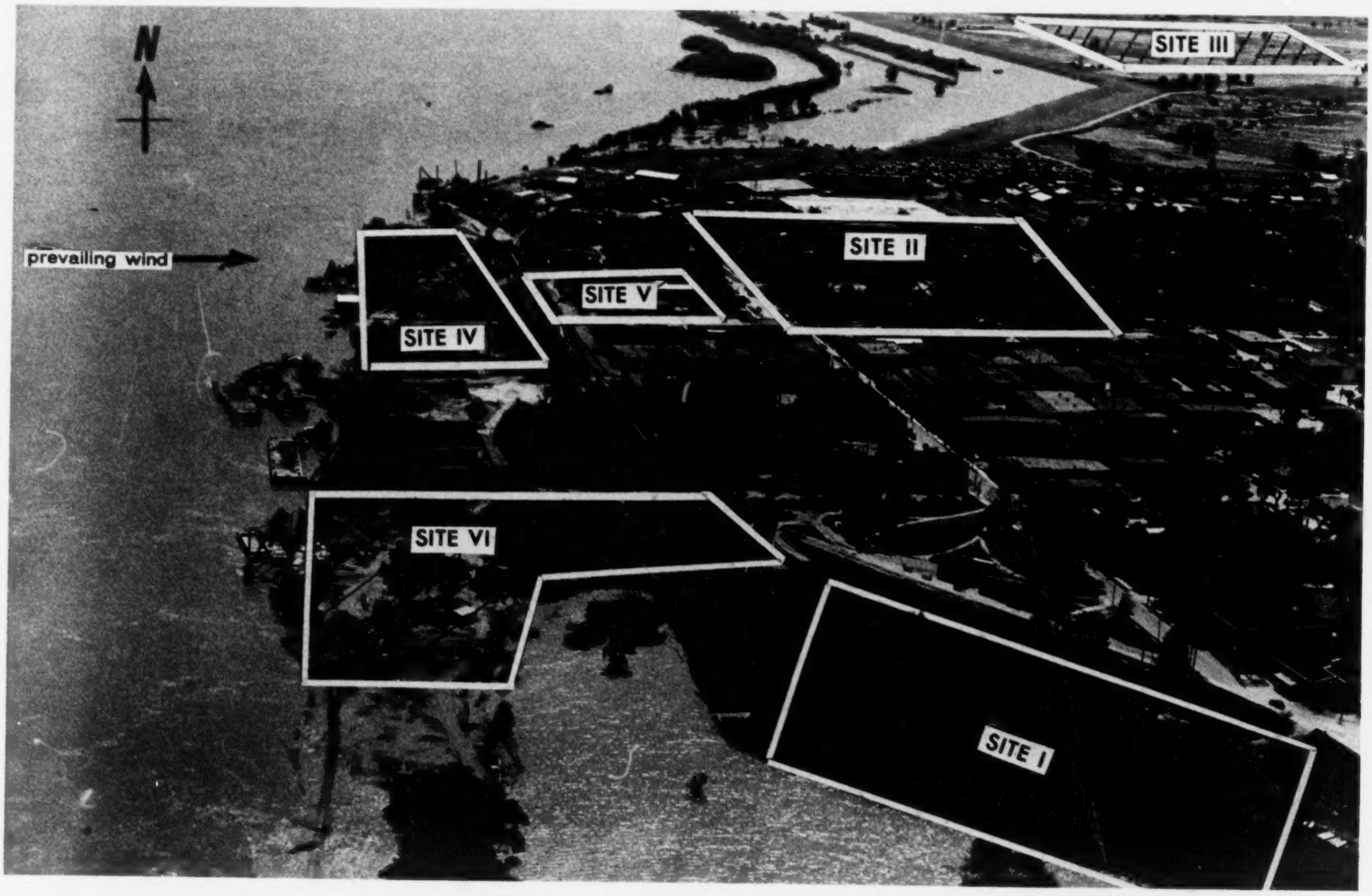


Fig. 6-1. Construction Sites

Fig. 6-2. Site Feasibility Factors

| Site | Cost | Soil | Clearing Needed (yes, no) | Fill Required (yes, no) | Zoning | Utilities<br>A. water<br>B. sewage<br>C. electric<br>D. gas | Access (good, poor) | Property Tax per Year | Labor Supply (yes, no) | Location (good, poor) | Climate |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | $100,000 | Firm | | | Commercial | A B C D | | $1,000 | yes | | Constant Wind |
| II | $200,000 | Hard | | | Residential | A B C D | | $2,000 | yes | | Good |
| III | $ 50,000 | Firm | | | Unzoned | A | | $ 200 | yes | | Floodable |
| IV | $300,000 | Firm | | | Commercial | A B C D | | $3,000 | yes | | Wind, Floodable |
| V | $400,000 | Firm | | | Commercial | A B C D | | $4,000 | yes | | Good |
| VI | $100,000 | Soft | | | Unzoned | A C | | $1,000 | yes | | Wind, Floodable |

**Examine Fig. 6-1 and fill in the blank spaces for each site.**

ACTIVITY 7

# Buying Real Estate

Today you will do some exercises with the *direction circle.* Then you will survey a model piece of land by following a property description like the ones surveyors use.

## Problem

### Objective:

Using a legal description of a lot, use a direction circle and rule to lay out a scaled-down model lot.

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | claw hammer |
| 1 | steel tape |
| 1 pr. | scissors |
| 1 | framing square |

**Supplies** (Group of 5)

| | |
|---|---|
| 1 pc. | ½″ x 12″ x 12″ plywood with monument marker |
| 1 pc. | ½″ x 48″ x 48″ plywood |
| 5 | 4d finishing nails |
| 1 | direction circle (in Laboratory Manual) |
| 14 ft. | string |

### Material Preparation and Practice

1. Very lightly draw a straight line from the center of the circle (Fig. 7-1) in the following directions.
   a. N 70° E
   b. S 25° E
   c. N 50° W
   d. S 90° W
   e. N 5° E
   f. S 85° W
2. Cut out the direction circle. See Fig 7-1.
3. Place a ½″ x 48″ x 48″ piece of plywood on your workbench.
4. Find and mark the approximate center of the plywood. Draw lines to show the compass points. See Fig. 7-3. Make sure that the north-south and east-west lines are parallel to the edges of the plywood.

### Reading Property Description

5. Read the property description in Fig. 7-2 and follow the directions for your survey.

Fig. 7-2. Property Description

> Beginning at the center of a monument located on the north line of Lea Drive in the village of Marion, New York, proceed S 25° W twelve feet (12′) from the monument to an iron pipe on the south line of Lea Drive; thence due south along the west property line of property owned by Mr. Ury eighty-four feet (84′) to an iron pipe on the north line of property owned by Mr. Ryan; thence N 80° W seventy-six feet (76′) to an iron pipe on the east property line of property owned by Mr. Johns; thence N 10° W seventy-three feet (73′) to an iron pipe on the south line of Lea Drive; thence due east eighty-eight feet six inches (88½′) to place of beginning.

### Surveying

6. Place the small monument board at the northeast corner of the large plywood board. See Fig. 7-3.
7. Place the center of the direction circle over the monument (nail). Place the circle so that north and south line up with north and south on the monument board. See Fig. 7-4.
8. Use the scale ½″ = 1′ to measure distances.
9. Extend a line from the monument, S 25° W 12′. (The scaled distance will be

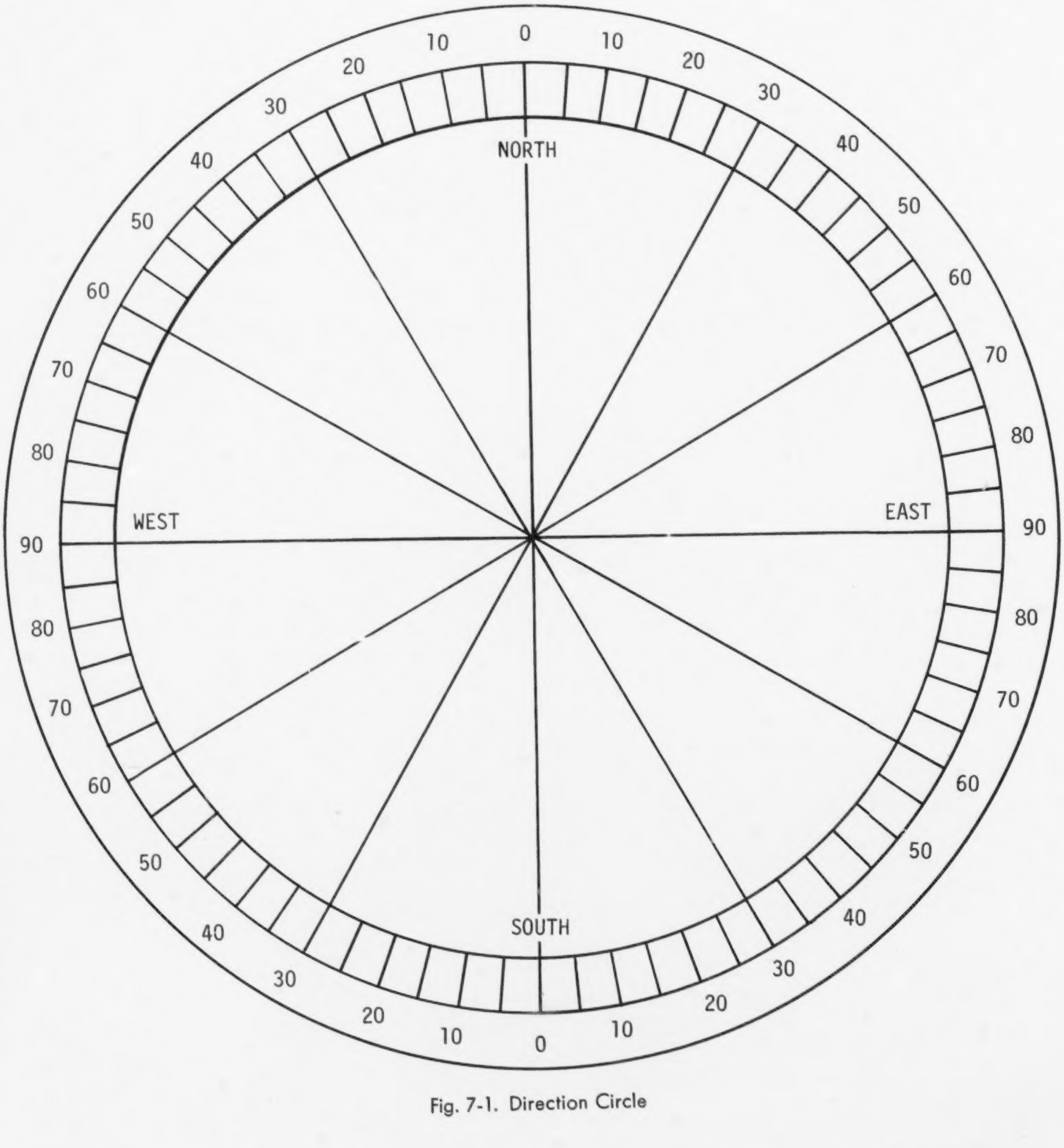

0
10
20
30
40
50
60
70
80
90
NORTH
EAST
SOUTH
WEST

Fig. 7-1. Direction Circle

6″.) Drive a nail at this point (Point A). Do not draw lines on the plywood. See Fig. 7-5.

10. Place the direction circle over Point A, and measure 84′ due south. *Each time you place the direction circle,* use a framing square to *make sure that north points due north.* See Fig. 7-6. Drive a nail at this point (Point B), Fig. 7-6.
11. Place the direction circle over Point B, and measure 76′ N 80° W along the north property line of Mr. Ryan. Drive a nail at this point (Point C). See Fig. 7-7.
12. Place the direction circle over Point C, and measure 73′ N 10° W along the east property line of Mr. Johns. Drive a nail at this point (Point D). See Fig. 7-8.

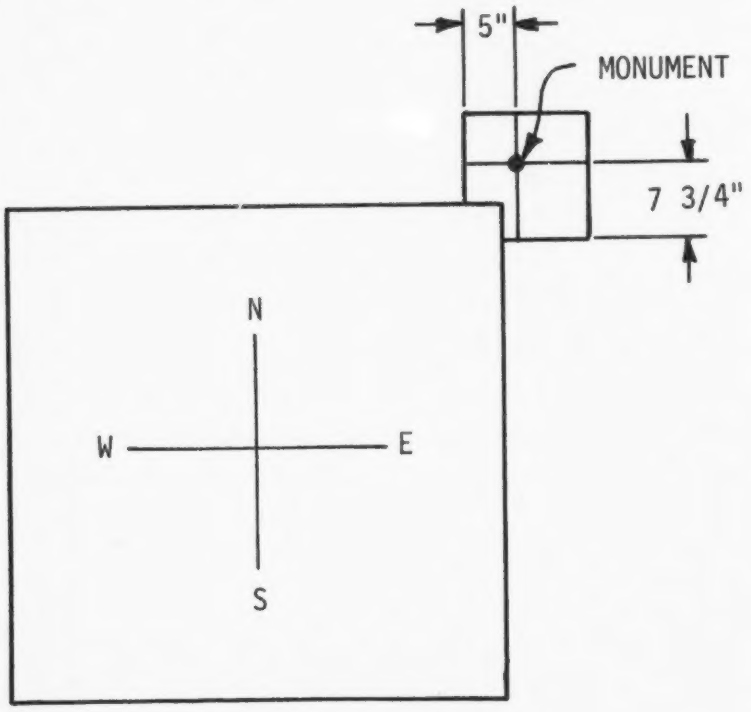

5"
MONUMENT
7 3/4"
N
W
E
S

Fig. 7-3. Monument Board Placement

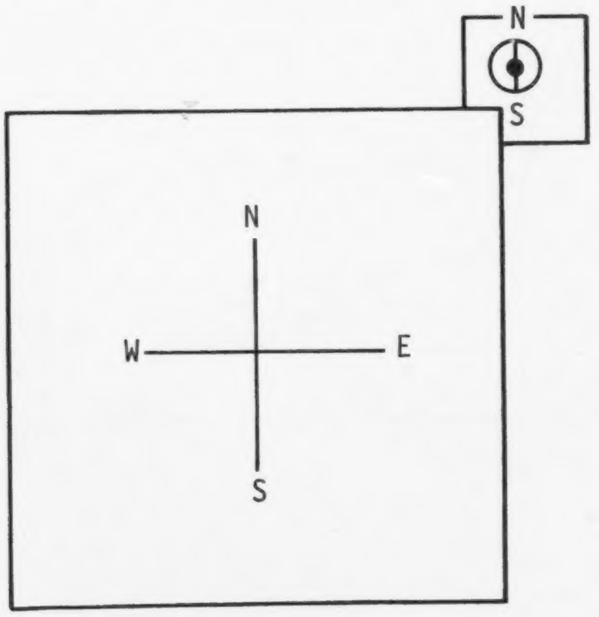


Fig. 7-4. Direction Circle in Place

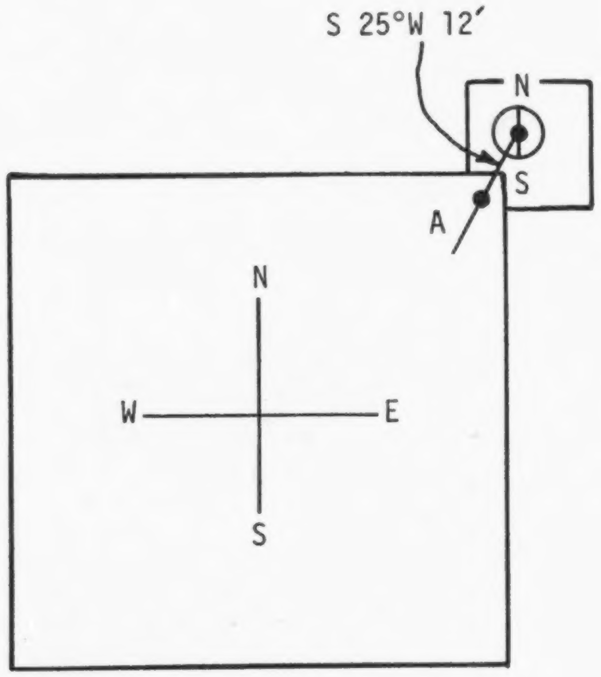

S 25°W 12′
N
S
A
N
W
E
S

Fig. 7-5. Locating Point A

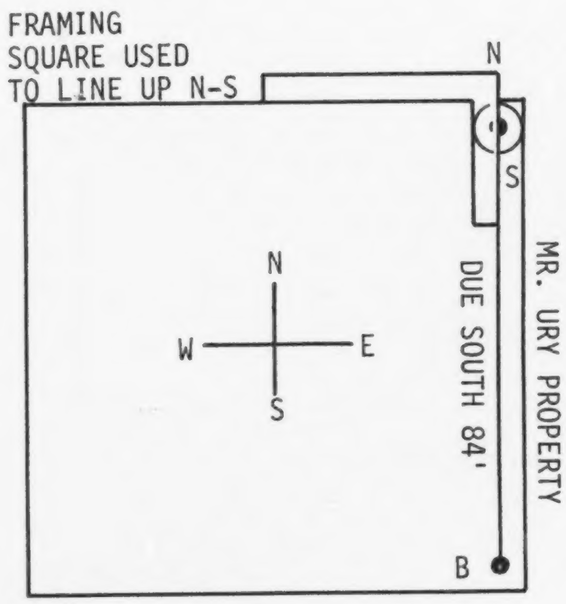

FRAMING
SQUARE USED
TO LINE UP N-S
N
S
N
W
E
S
DUE SOUTH 84'
MR. URY PROPERTY
B

Fig. 7-6. Locating Point B

13. Place the direction circle over Point D, and measure 88½′ along the south line of Lea Drive to the place of beginning (Point A). See Fig. 7-9. Join Points A, B, C, D with a piece of string. See Fig. 7-10.

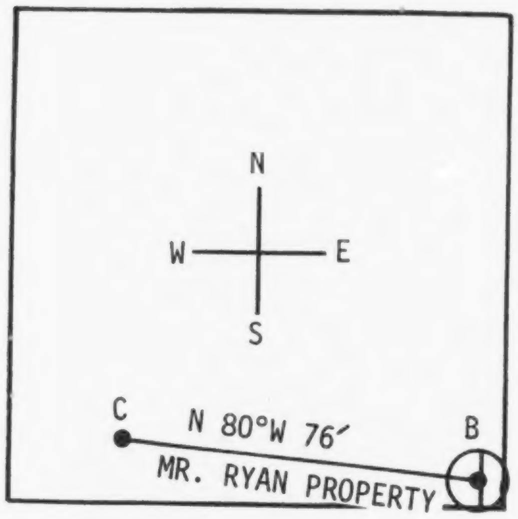

N
W
E
S
C
N 80°W 76′
B
MR. RYAN PROPERTY

Fig. 7-7. Locating Point C

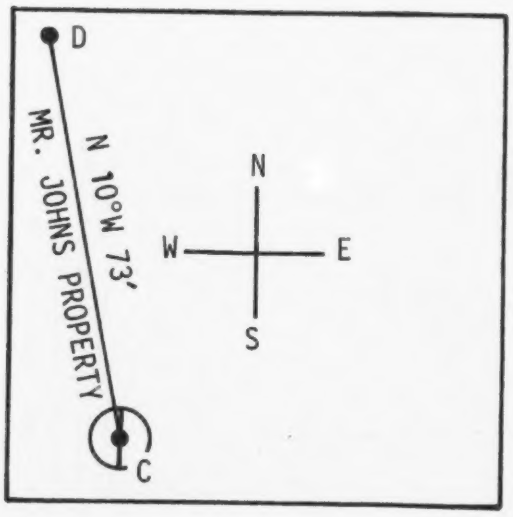

D
N 10°W 73′
MR. JOHNS PROPERTY
N
W
E
S
C

Fig. 8-8. Locating Point D

## Verifying Property Description

14. When you finish, your layout should look like the plot plan in Fig. 7-10.

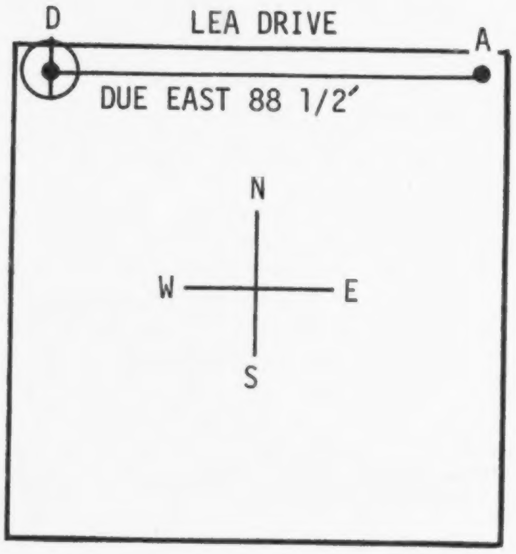

D
LEA DRIVE
A
DUE EAST 88 1/2′
N
W
E
S

Fig. 7-9. Checking Point A

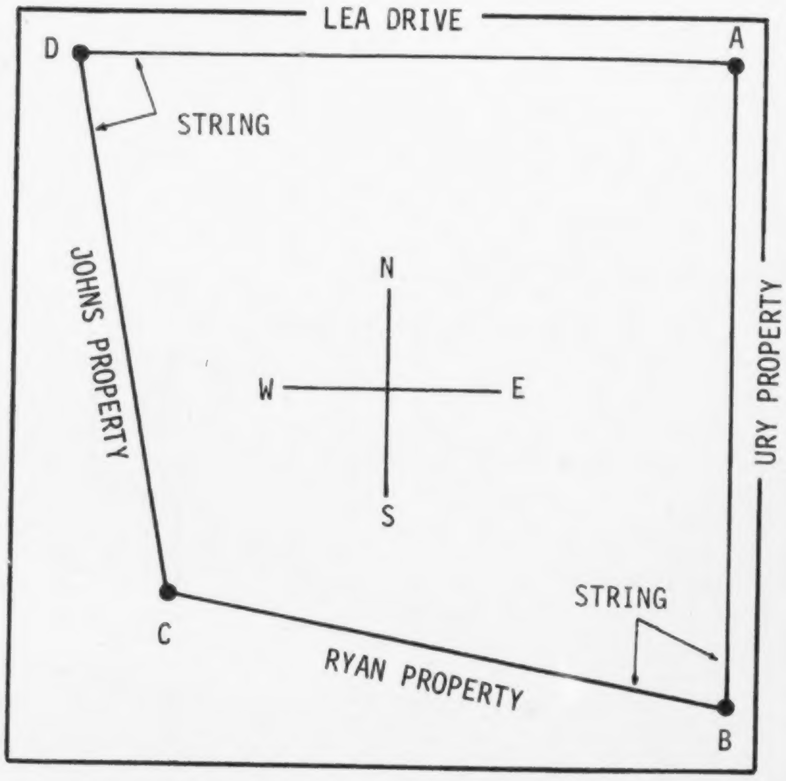

LEA DRIVE
D
A
STRING
JOHNS PROPERTY
N
W
E
S
URY PROPERTY
STRING
C
RYAN PROPERTY
B

Fig. 7-10. Plot Plan

**ACTIVITY 8A**

# Surveying and Mapping

Today you will work with a model hill, finding elevations and making a topographic map. You will work with a site box that represents a site which is 1,350′ by 2,100′ in area.

**Problem**

## Objective:

Using a site box, a level bar, stadia rod, and grid chart:

a. Measure elevations with a level and a stadia rod.
b. Record elevation data on a grid chart.
c. Draw contour lines between like elevation points.

### Equipment

| | |
|---|---|
| 1 | site box with sand |
| 1 | level bar |
| 1 | stadia rod |
| 1 | 6d nail for holding level bar on site box |

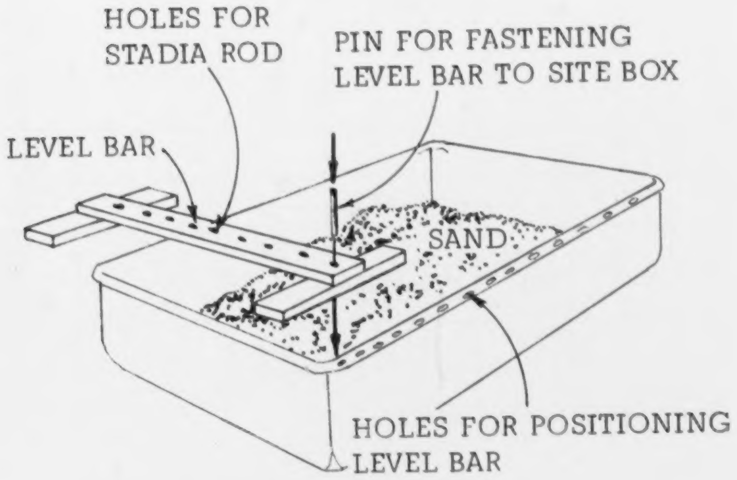

HOLES FOR STADIA ROD
PIN FOR FASTENING LEVEL BAR TO SITE BOX
LEVEL BAR
SAND
HOLES FOR POSITIONING LEVEL BAR

Fig. 8A-1. Surveying Equipment

### Supplies

| | |
|---|---|
| 1 | grid chart |
| 1 | pencil |

## Preparing Materials

1. Arrange the sand into a large hill in the center of the site box.
2. Place the level bar on one end of the site box. See Fig. 8A-1.
3. Place the stadia rod into the level bar in the hole nearest you. See Fig. 8A-2.

## Surveying

4. Starting at the end of the level bar (see Fig. 8A-2), lower the stadia rod through

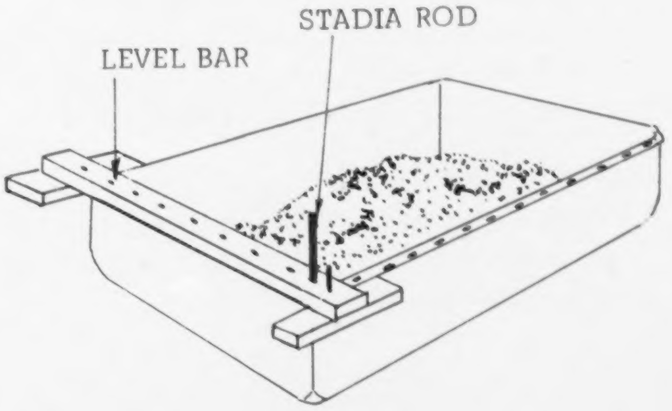

STADIA ROD
LEVEL BAR

Fig. 8A-2. Locating Stadia Rod

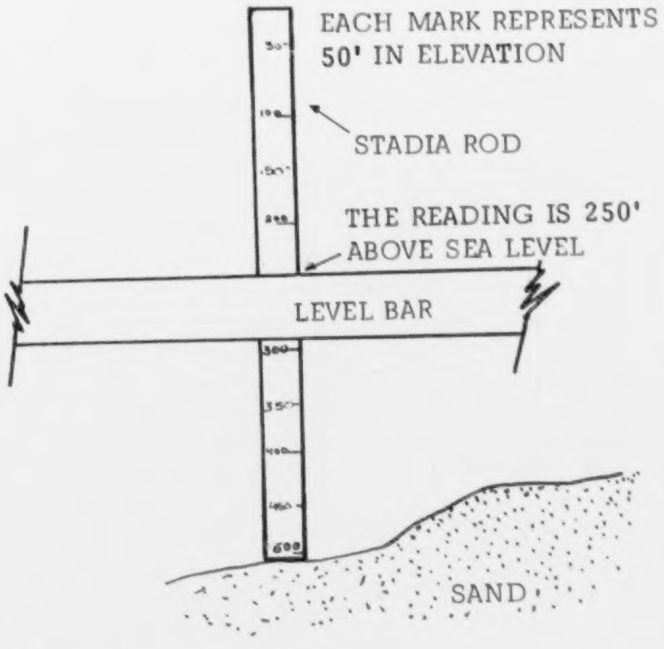

EACH MARK REPRESENTS 50' IN ELEVATION
STADIA ROD
THE READING IS 250' ABOVE SEA LEVEL
LEVEL BAR
SAND
50
100
150
200
300
350
400
450
500

Fig. 8A-3. Reading Stadia Rod

the level bar until it touches the sand. Read the elevation to the nearest 50′ interval. See Fig. 8A-3.

## Reading and Recording

5. Record the elevation in the lower left corner of Fig. 8A-8. The numbers should be placed in the upper left-hand corner of the square, *not* at the intersection. See Fig. 8A-4.
6. Move the stadia rod to the next hole and record the new elevation in the square above the first elevation. See Fig. 8A-5. Repeat this procedure for each hole in the level bar.

## Continue Surveying and Recording

7. Continue to move the level bar and stadia rod until an elevation is recorded for all points on the grid chart. See Fig. 8A-6.

## Drawing Contour Lines

8. With a line, connect all points having the same elevation. See Fig. 8A-7. These lines are called *contour lines.*

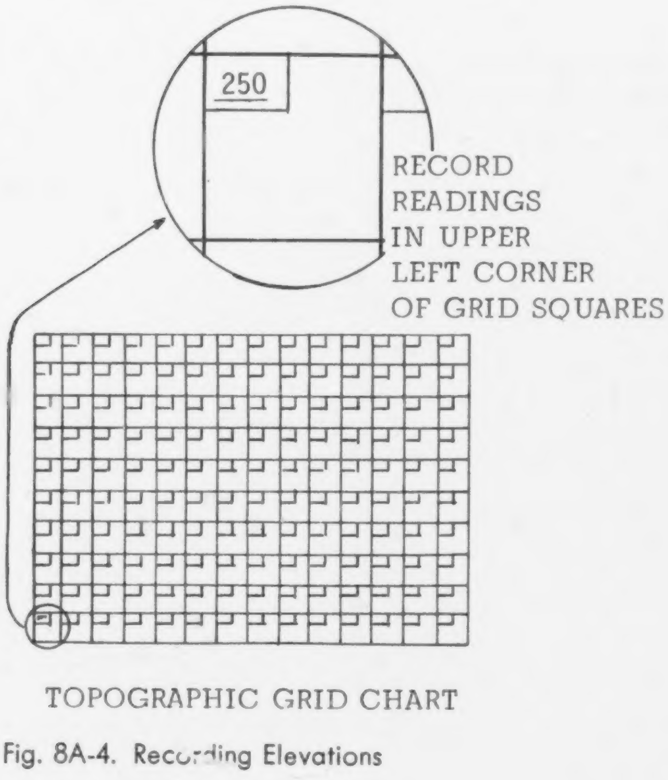

250
RECORD READINGS IN UPPER LEFT CORNER OF GRID SQUARES
TOPOGRAPHIC GRID CHART

Fig. 8A-4. Recording Elevations

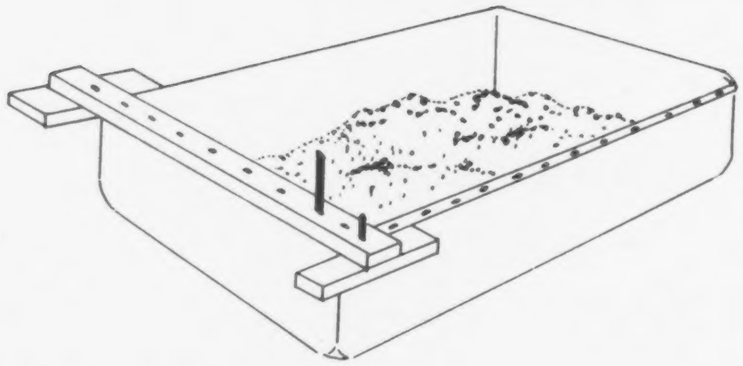


Fig. 8A-5. Relocating Stadia Rod

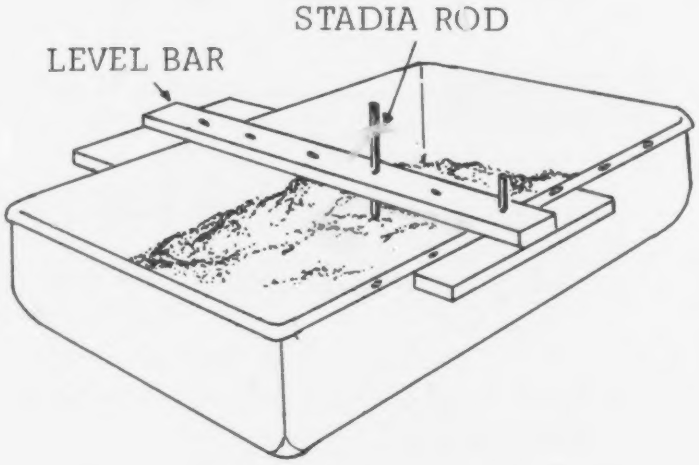

STADIA ROD
LEVEL BAR

Fig. 8A-6. Relocating Level Bar and Stadia Rod

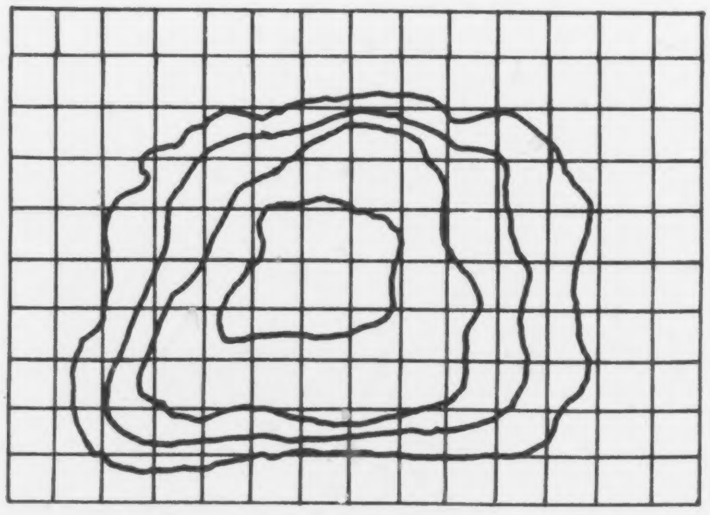


Fig. 8A-7. Drawing Contours

PROCEDURE:

1. Record readings for each point in upper left-hand corner of each square.
2. Draw contour lines to connect all like numbers. (Activity 8B shows a completed topographic map.)

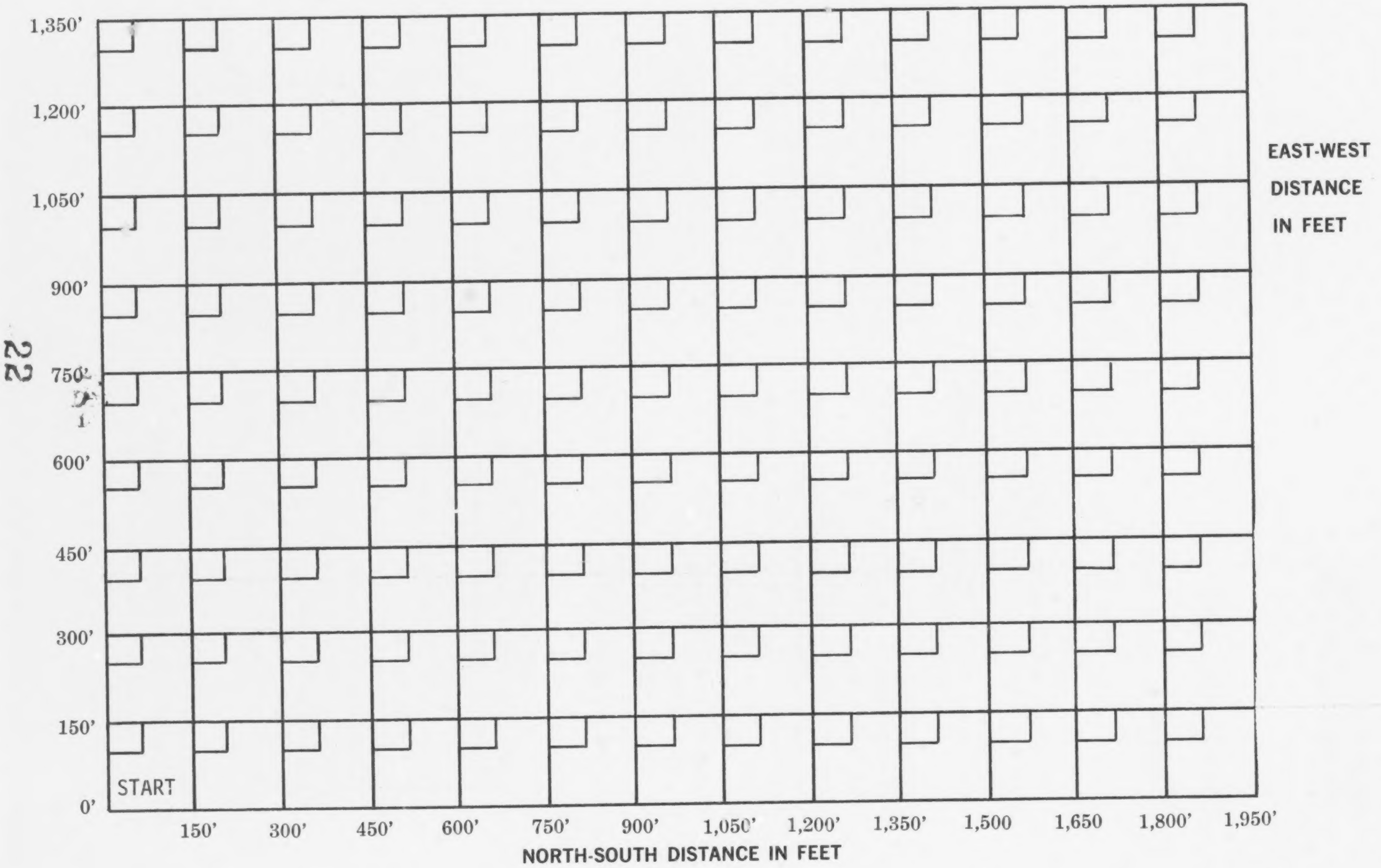

1,350'
1,200'
1,050'
900'
750'
600'
450'
300'
150'
0'
START
150'
300'
450'
600'
750'
900'
1,050'
1,200'
1,350'
1,500
1,650
1,800'
1,950'
NORTH-SOUTH DISTANCE IN FEET
EAST-WEST DISTANCE IN FEET

Fig. 8A-8. Topographic Grid for Map Making

**ACTIVITY 8B**

# Surveying and Mapping

Today you will draw two *profiles* that will show the shape of the land surface along a highway route. Then you will try to select a better route for the highway and explain why it is a better route.

**Problem**

## Objective:

Using a topographic map showing a proposed highway route, and two profile charts, plot one profile of the land surface along the length of the proposed route and another profile cutting across the route in one place.

**Equipment** (Each student)

| | |
|---|---|
| 1 | straightedge or rule |
| 1 | sharp pencil |
| 1 | eraser |
| 1 | colored pencil |

## Locating Points

1. Find line AA on the Topographic Grid Chart, Fig. 8B-1. Imagine that you are cutting straight down into the earth along this line. You are going to draw a profile of the land surface along this *cut* or *cutting plane.*
2. On the Topographic Grid Chart (Fig. 8B-1), most of the contour lines meet and cross line AA. *From each one* of these crossing points, you are to draw a light line straight downward through Profile Chart A. Figure 8B-2 shows you how to do this.

## Projecting Points

3. The edge of Profile Chart A is labeled to show elevation in feet. On each of your pencil lines, mark the elevation that matches the contour line. For example, the line you drew downward from a 920′ contour should be marked on the profile chart at the 920′ reading. See Fig. 8B-3.
4. Erase the lines you drew from the topographic map, but do not erase the elevation points.

## Profiling

5. Draw the profile by connecting the points on the profile charts. See Fig. 8B-4.

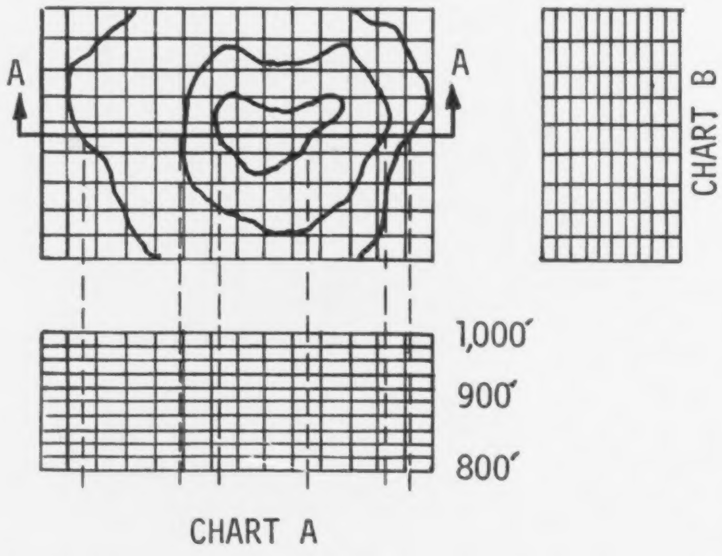


Fig. 8B-2. Projecting Profile Points

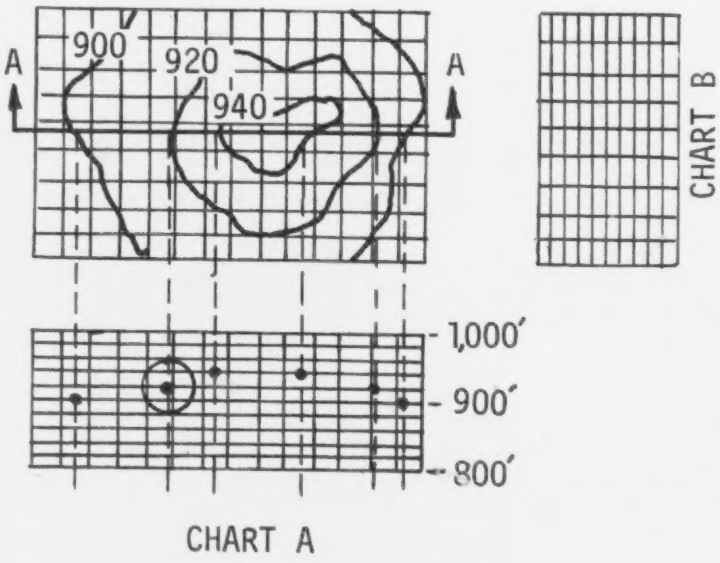


Fig. 8B-3. Locating Profile Points

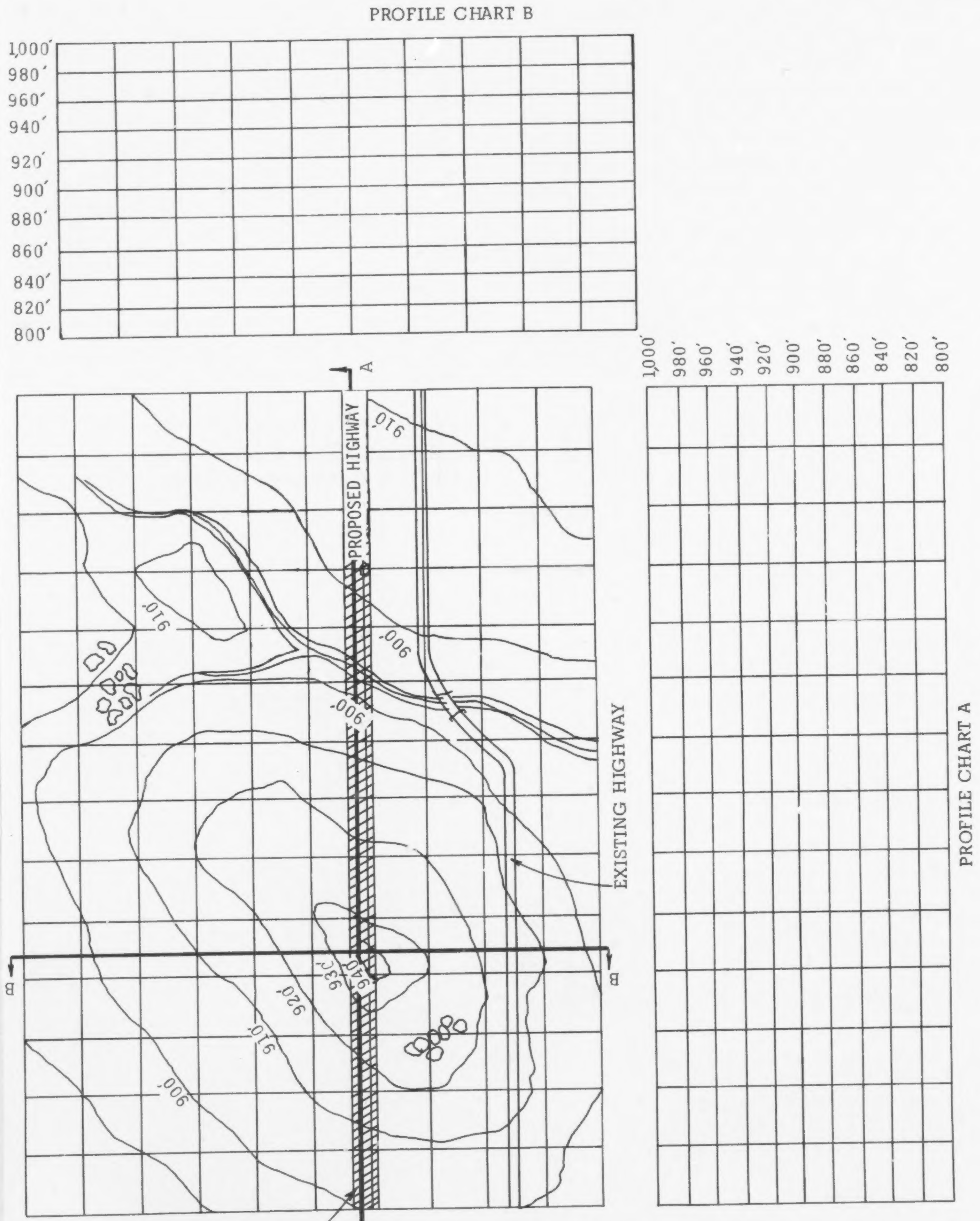

PROFILE CHART B
1,000′
980′
960′
940′
920′
900′
880′
860′
840′
820′
800′
A
PROPOSED HIGHWAY
910′
900′
920′
930′
940′
B
EXISTING HIGHWAY
PROFILE CHART A

Fig. 8B-1. Topographic Grid Chart

### Determining Cut and Fill

6. The proposed highway will have an elevation of 910′. Draw a line on your profile chart along the 910′ level. Shade the part of the chart that is between the profile line and the proposed highway elevation. See Fig. 8B-5.
7. Find line BB on the Topographical Grid Chart. Imagine cutting into the earth along this line. You are going to draw a profile of a cut through BB.
8. Follow steps 1 to 6 to make a profile of BB on Profile Chart B. See Fig. 8B-6.

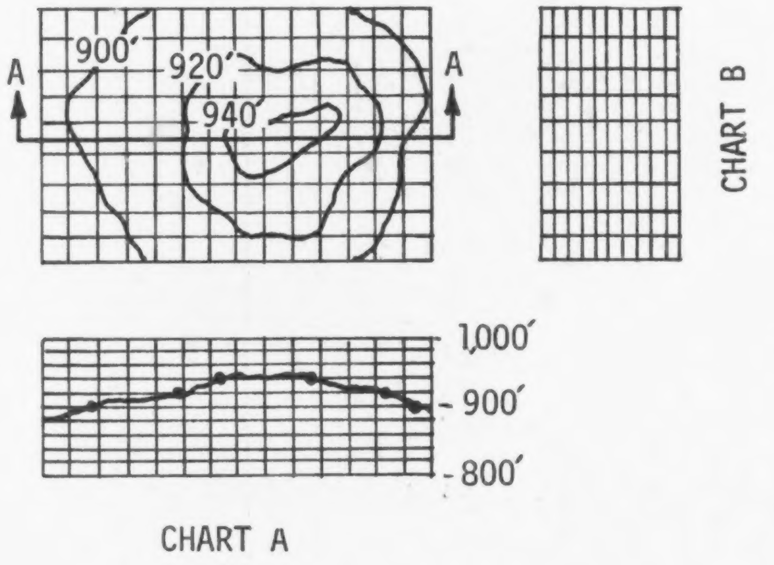

900′
920′
940′
A
A
CHART B
1,000′
900′
800′
CHART A

Fig. 8B-4. Drawing Profile

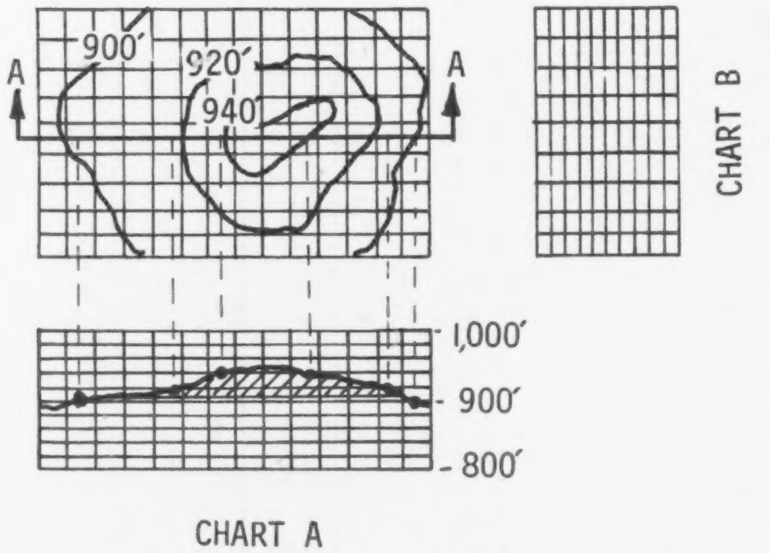

900′
920′
940′
A
A
CHART B
1,000′
900′
800′
CHART A

Fig. 8B-5. Shading Cut and Fill

### Questions

1. A profile can be easily made from a to____________________ map.
2. A profile shows the el________________ of the land surface.
3. A h____________________ is shown as a hump on the profile chart.
4. What are the intervals (in feet) between the elevation lines marked on your profile charts (Fig. 8B-1)?

   ________________________
5. What are the intervals between contour lines on your topographic map (Fig. 8B-1)?

   ________________________

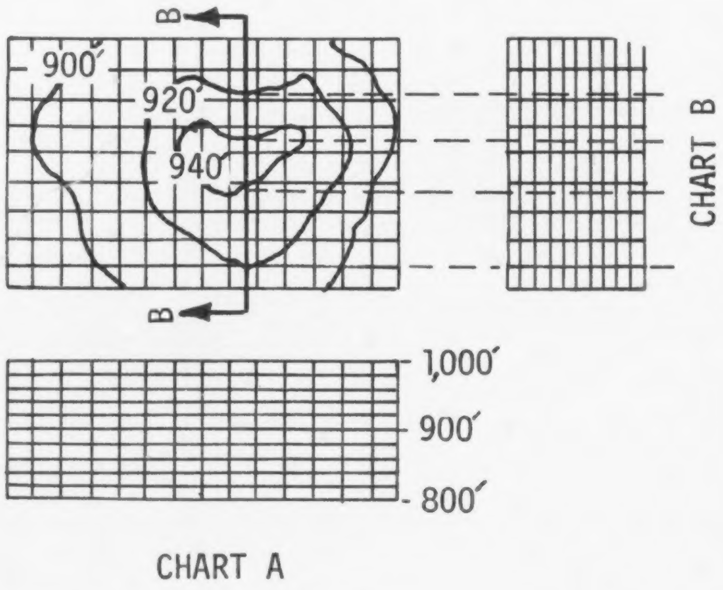

B
900′
920′
940′
B
CHART B
1,000′
900′
800′
CHART A

Fig. 8B-6. Projecting Profile Points

## ACTIVITY 9A

# Soil Testing

## Problem

### Objective:

Using measuring devices, containers and soil samples:

a. Analyze two soil samples, clay and sand, to find out if excavation facing is needed.
b. Test two soils, clay and sand, for water absorption.
c. Analyze the soil strengths of clay and sand.

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | plastic tray |
| 2 | plastic funnels |
| 1 | measuring cup |
| 2 | teaspoons |
| 1 pr. | scissors |

**Supplies** (Group of 5)

| | |
|---|---|
| 2 | 1¼″ x 14″ corrugated metal strips |
| 2 | 8 oz. paper cups |
| 1 qt. | sand (damp) |
| 1 qt. | clay (damp earth) |
| 1 | ½ gallon milk carton |
| 4 | 1″ x 1″ x 4″ wooden blocks |

### Preparing to Test

1. Work in groups of five students. Get your equipment and supplies. Take turns or share the tasks in this activity.
2. Cut the milk carton in half lengthwise to make two shallow pans. See Fig. 9A-1. Cut several drain holes in the flat side that will form the bottom of each pan.
3. Place both pans inside the plastic tray so that they rest on the wooden blocks.
4. Pack the damp sand into one pan and the clay into the other.
5. With a spoon, "excavate" (dig) a trench through center of each soil sample. See Fig. 9A-2.

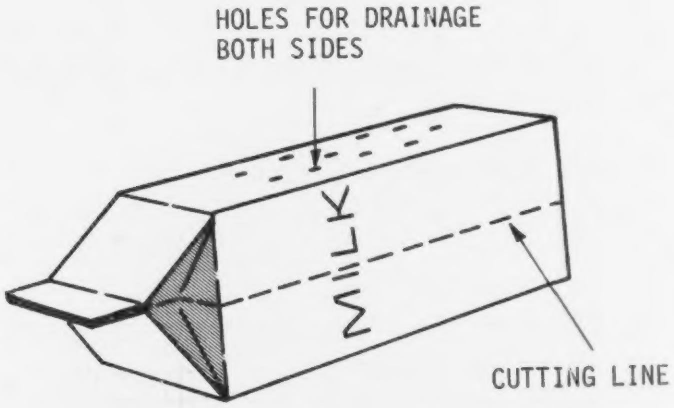


Fig. 9A-1. How to Make Pans by Cutting Milk Cartons

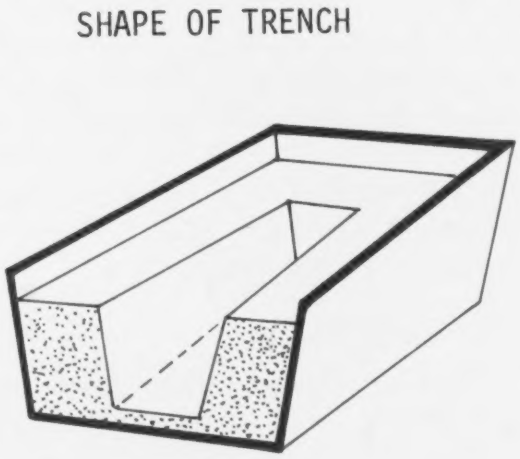
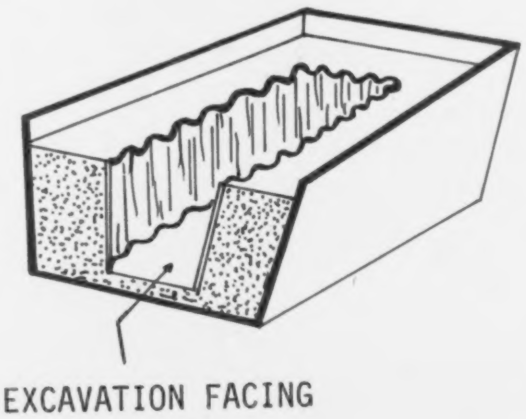


Fig. 9A-2. Excavation



CORRUGATED METAL FACING ADDED FOR TRENCH SUPPORT

Fig. 9A-3. Trench Facing

6. If soil keeps falling into the trench, bend and place corrugated metal strips (facing) into position and press them into the soil until the top is almost even with the soil. Then go on with the excavating. See Fig. 9A-3.
7. In Fig. 9A-6 answer the two questions under the heading "Excavation Characteristics."

## Water Absorption Testing

8. On one side of each trench, insert the funnel stem until it just goes into the soil. See Fig. 9A-4.
9. Fill both paper cups with equal amounts of water. Measure carefully so that as water is used, you can see the difference. See Fig. 9A-5.
10. Pour water into the funnel until water stands on the surface of the soil. Then move the funnel to four other locations around the excavation. *Never pour more water than the soil will absorb* (soak up).
11. Wait 3 minutes. Then answer the three questions under "Water Absorption Testing" in Fig. 9A-6.

## Soil Strength Testing

12. With your thumb, press down on the soil sample and try to get an idea of the capacity of each kind of soil to carry a load when wet.
13. Fill the plastic tray with water until the bottom of the soil pans are covered about 1″. See Fig. 9A-7.
14. Allow the water to stand for 3 minutes. Check about every 30 seconds by pressing down on the soil with your thumb to see if the soil is gaining or losing strength.
15. In Fig. 9A-6 answer the four questions under the heading "Soil Strength Testing."

## Removing Trench Facing

16. Carefully remove the facing and observe what happens.
17. Answer the remaining questions under "Facing Removal Testing" and "Conclusions."

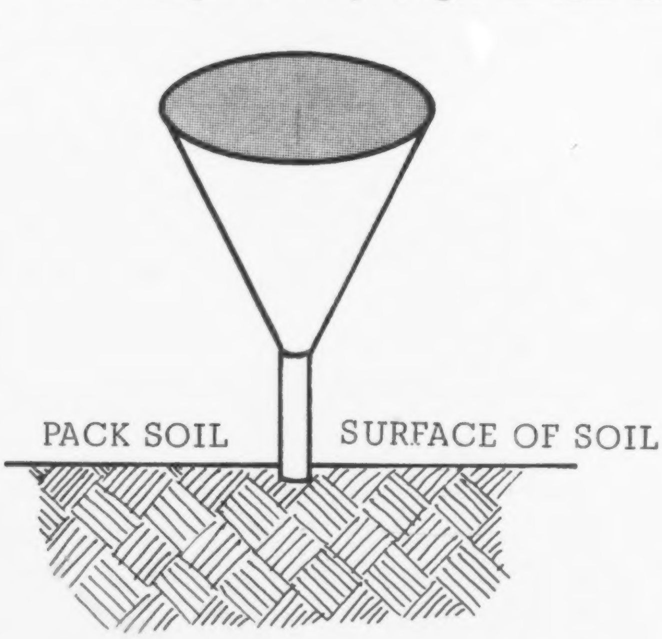


Fig. 9A-4. Funnel Placement

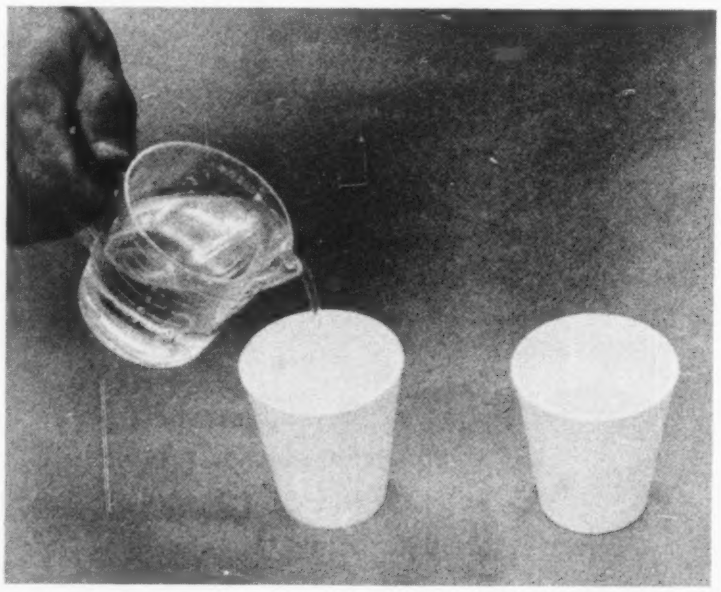


Fig. 9A-5. Measuring Water

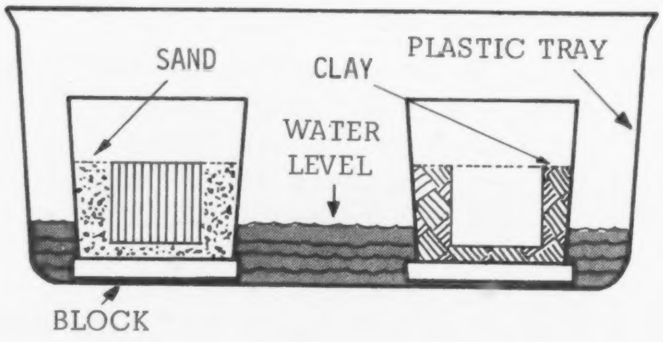


Fig. 9A-7. Testing for Absorption

## Cleaning Up

18. Remove the soil samples and dispose of them as your teacher tells you.
19. Pour the water out of the plastic tray, wipe it dry, and return it to storage.

Fig. 9A-6. Soil Testing Results

| Questions | Clay | Sand |
|---|---|---|
| **Excavation Characteristics** (Yes/No) | | |
| Facing needed? | ____ | ____ |
| Excavation walls kept their shape? | ____ | ____ |
| **Water Absorption Testing** | | |
| Number of cups used? | ____ | ____ |
| Absorbed most water? (Check one) | ____ | ____ |
| Absorbed least water? (Check one) | ____ | ____ |
| **Soil Strength Testing** (Yes/No) | | |
| Water in trench? | ____ | ____ |
| Soaked up most water? | ____ | ____ |
| Lost strength (no resistance to load)? | ____ | ____ |
| Gained strength (resisted load)? | ____ | ____ |
| **Facing Removal Testing** | | |
| Did trench sides give way? (Yes/No) | ____ | ____ |
| **Conclusions** (Check One) | | |
| Which was more stable when damp? | ____ | ____ |
| Which was more stable when wet? | ____ | ____ |
| Which can support a greater load? | ____ | ____ |
| Which is better for foundations? | ____ | ____ |
| Which is better for excavations? | ____ | ____ |

**ACTIVITY 9B**

# Soil Testing

**Problem**

## Objective:

Using soil samples of clay and sand:

a. Test and compare the strength of two soil samples after water has evaporated.

b. Find the percent of soil compaction by measuring and computing.

c. Evaluate the two soils for building sites.

**Equipment** (Group of 5)

1 12" rule

**Supplies** (Group of 5)

2 cartons with soil samples from Activity 9A

2 1 lb. coffee cans

1 1" x 1" x 4" wooden tamping block

paper towels

## Preparing Materials

1. Obtain your soil samples still in their trays from Activity 9A. Look at them carefully. Touch the surface.

## Testing Compaction

2. Press on the soil samples with your thumb to find out if the soil feels stronger or harder to press down as a result of being wet and drying out. See Fig. 9B-1.
3. Answer the questions in Fig. 9B-2 under the heading "Surface Qualities."

## Testing Internal Strength

4. Dump the clay sample from its container onto paper towels. Dump the sand sample onto paper towels on another part of the workbench. See Fig. 9B-3.
5. Feel each soil sample and answer the questions under "Internal Strength."

## Measuring Compaction

6. Break each of the soil samples into chunks no larger than 1" in dimension and loosely fill each can. Place all extra material to one side. See Fig. 9B-4.
7. Tamp the soil in each can with a wooden block. See Fig. 9B-5. Measure the distance from the top of the cans to the

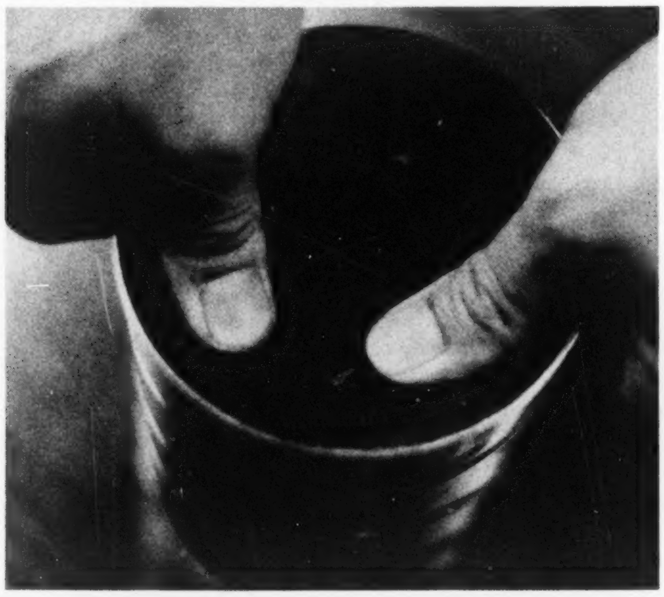


Fig. 9B-1. Compressing Soil

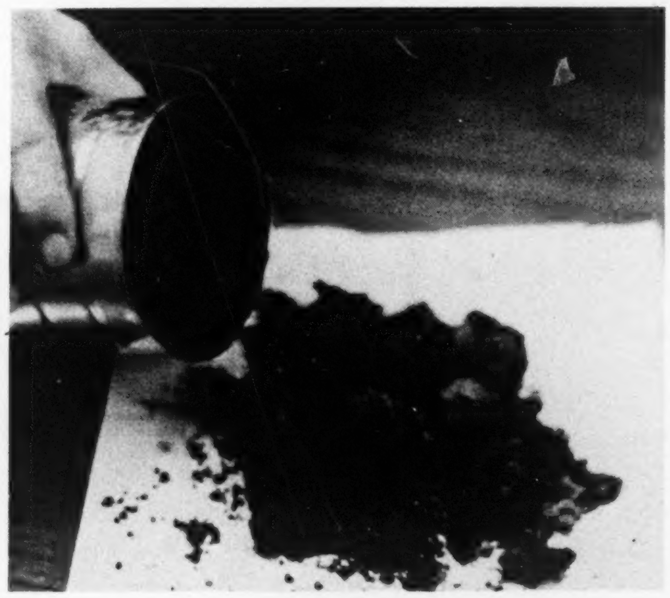


Fig. 9B-3. Dumping Soil

soil. Record these measurements under "Compaction" (A).

8. Pour the contents of *each can* onto *separate* paper towels.
9. Now place each soil sample into the same can again, but this time in 1″ layers. Tamp and compact each layer with the wooden block.
10. Measure how much space remains at the top of each can. Record these measurements under "Compaction" (B). Answer questions under "Compaction" and "Conclusion."

## Cleaning Up

11. Clean up your work area according to the teacher's directions.

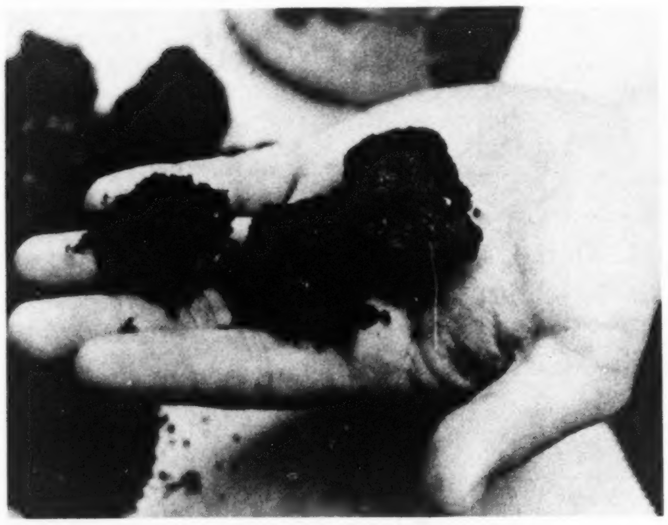


Fig. 9B-4. Examining Soil

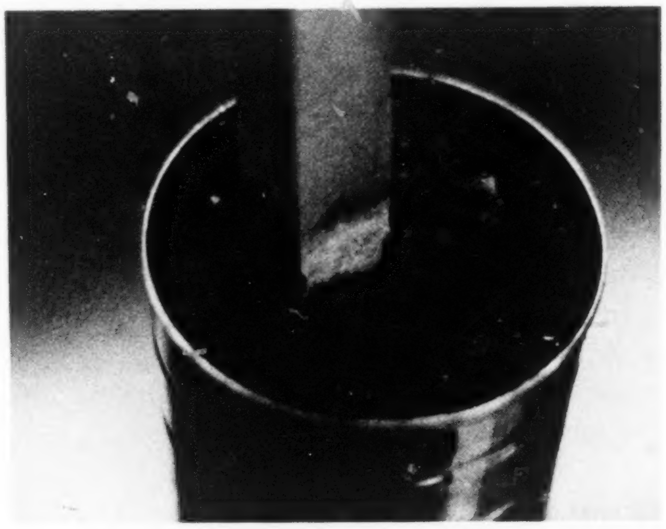


Fig. 9B-5. Compacting Soil

Fig. 9B-2. Results of Further Soil Testing

| Questions | Sand | Clay |
|---|---|---|
| **Surface Qualities, 24 Hours After Watering** | | |
| How does the surface feel? (Dry/Wet) | ____ | ____ |
| Is the sample harder to compress than it was before watering? (Yes/No) | ____ | ____ |
| **Internal Strength, Out of Container** | | |
| How does the soil feel? (Dry/Damp/Soggy) | ____ | ____ |
| Is it cohesive? (Do the bits stick together?) (Yes/No) | ____ | ____ |
| Do lumps fall apart easily when touched? (Yes/No) | ____ | ____ |
| **Compaction** | | |
| Soil depth after tamping. (A) | ____ | ____ |
| Soil depth after tamping. (B) | ____ | ____ |
| Which sample was compacted more? (A or B) | ____ | ____ |
| **Conclusion** | | |
| If you want compact fill, should all the fill be made and then tamped? (Yes/No) | ____ | ____ |

**ACTIVITY 10**

# Designing and Engineering Construction Projects

Today's activity involves five construction projects, each shown at a different stage of its design.

## Problem

### Objective:

Using figures and descriptions of construction projects in five different design stages, match the design step with the figure and indicate the designer.

### Classifying by Design Step

1. Review the design steps in Fig. 10-1. Decide which one of the six design steps each figure shows.
2. Record the design step under each figure.
3. Only five figures are shown. One step in Fig. 10-1 is not illustrated.

### Identifying the Designer

4. Would each project probably be designed by an architect, an engineer, or both working together? Write your answers under each figure.

Fig. 10-1. Six Basic Steps of the Design Process

| Design Step |
|---|
| 1. Identifying the problem |
| 2. Preliminary ideas |
| 3. Refining ideas |
| 4. Analyzing |
| 5. Deciding on one design |
| 6. Implementing the decision |

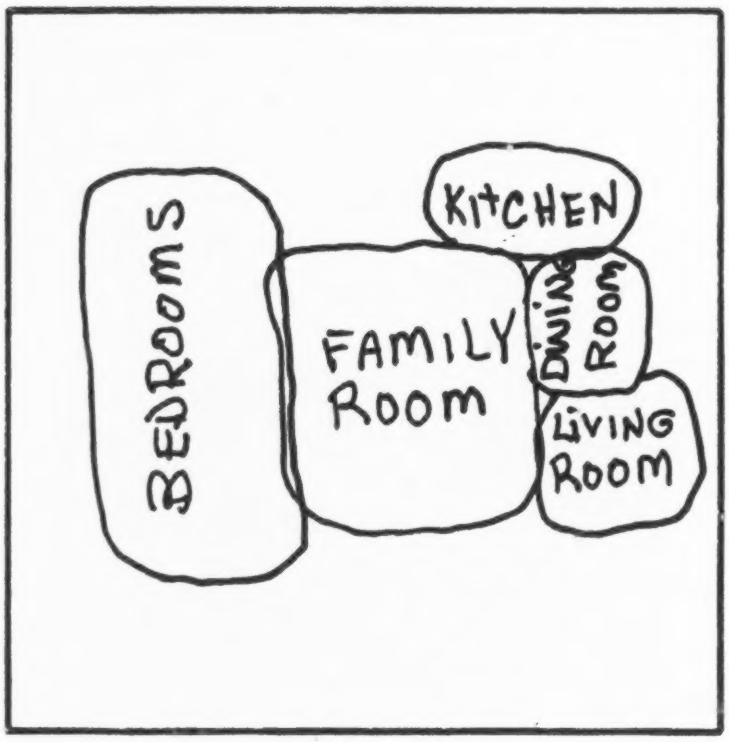


Fig. 10-2. Project A

Step ____________ Designer ____________

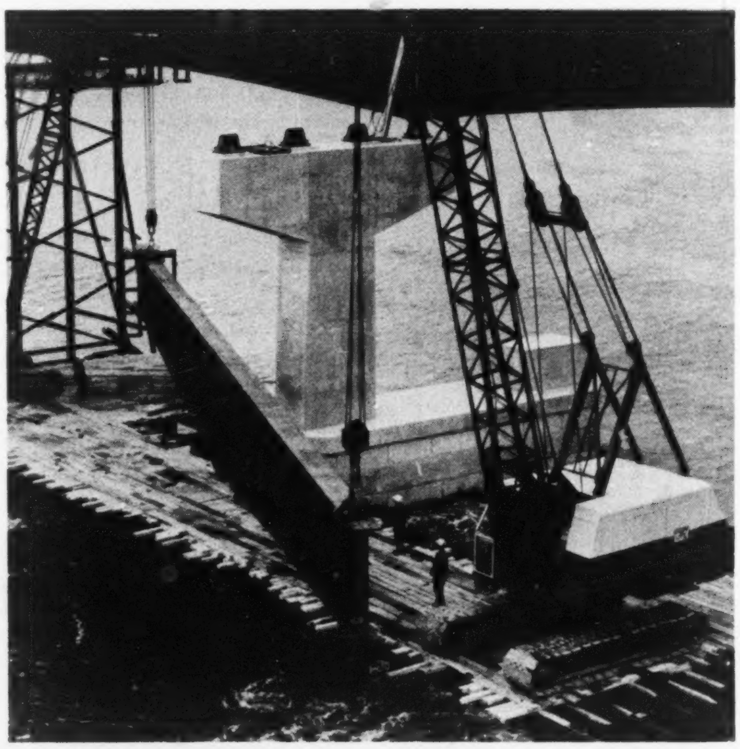


Fig. 10-3. Project B

Step ____________ Designer ____________

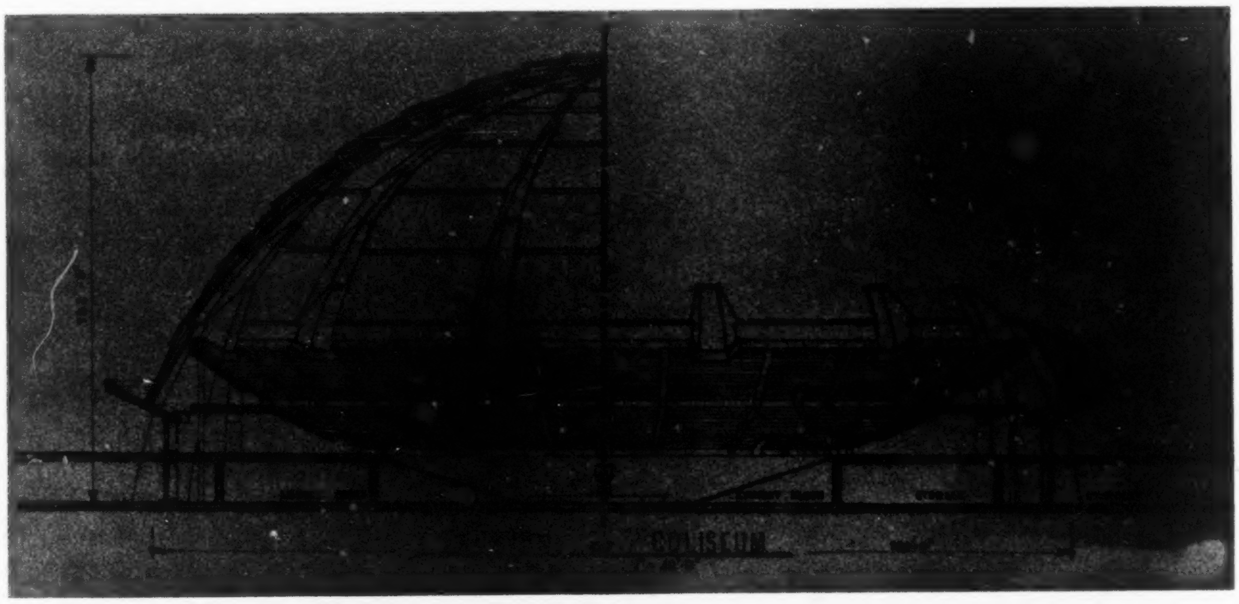


Fig. 10-4. Project C

Step

Designer

The length and weight of a beam have been chosen. The maximum load on the beam will be 5,000 pounds. The beam is to be supported by 2 columns, with the load distributed equally between them. How large a stress must the columns support?

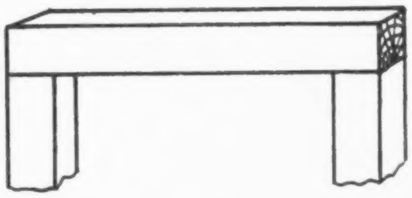


Fig. 10-5. Project D

Step

Designer

A garage, when completed, must permit clearing of cars in 20 minutes. Cars coming out of the garage should not have to cross the path of cars coming into the garage. The supports for the floors of the garage must be able to carry safely the weight of 2 more floors that may be added to the top of the garage in the future. The exterior materials should be similar in shape, color, and texture to the materials of the buildings around it.

Fig. 10-6. Project E

Step

Designer

**ACTIVITY 11**

# Identifying the Design Problem

In this activity, the designing of a community park, you will work as a designer does, identifying needs, gathering data, and applying data to a design problem.

**Problem**

## Objective:

1. Given the problem of designing a community park, point out the major needs (uses and purposes) that the park should meet.
2. Using the major needs to be met, list several kinds of data that will help to point out the needs.
3. Using the needs and related information, judge the data and decide the effect it has on the design problem.

## Identifying Needs

1. Figure 11-1 identifies four questions related to the use and purpose of a community park. Spend a few minutes reading and thinking about these questions.

## Gathering Data

2. Answer the questions listed in Fig. 11-1. Write your answers in the column labeled "Data Wanted."
3. Try to think of a source (a place to look for each kind of data). Complete the "Source" column.

## Judging Data

4. Some kinds of data are more useful after they are drawn up in a graph or other form of diagram. Study the data you listed under "Identifying Needs" and "Gathering Data." Decide for each kind of data whether or not it should be shown in a diagram. Write "yes" or "no" in the column labeled "Diagram."
5. What effects will the data have on the design problem? Record your thinking about this in the column labeled "Effect on Design Problem."
6. Your teacher will direct you to meet with a group and compare ideas after you you have worked alone for 10 minutes.

Fig. 11-1. Community Park Needs

| | Gathering Data | | Evaluating Data | |
|---|---|---|---|---|
| Identifying Needs | Data Wanted | Source | Diagram? | Effect on Design Problem |
| How many people will the park serve? | Number of people in the community | Library reference room | Yes | Number of tables in picnic area. Size of parking lot. Size of rest rooms |
| Where will the park be located? | Possible park sites | | | |
| What recreational facilities should be included? | | | | |
| What utilities should be available? | | | | |
| Others | | | | |

**ACTIVITY 12A**

# Developing Preliminary Ideas

**Problem**

## Objective:

Given the problem of designing a community park, develop beginning ideas for areas and structures.

**Supplies** (Each student)

2 paper clips
3 pcs. 8½″ x 11″ tracing paper

## Listing Beginning Ideas

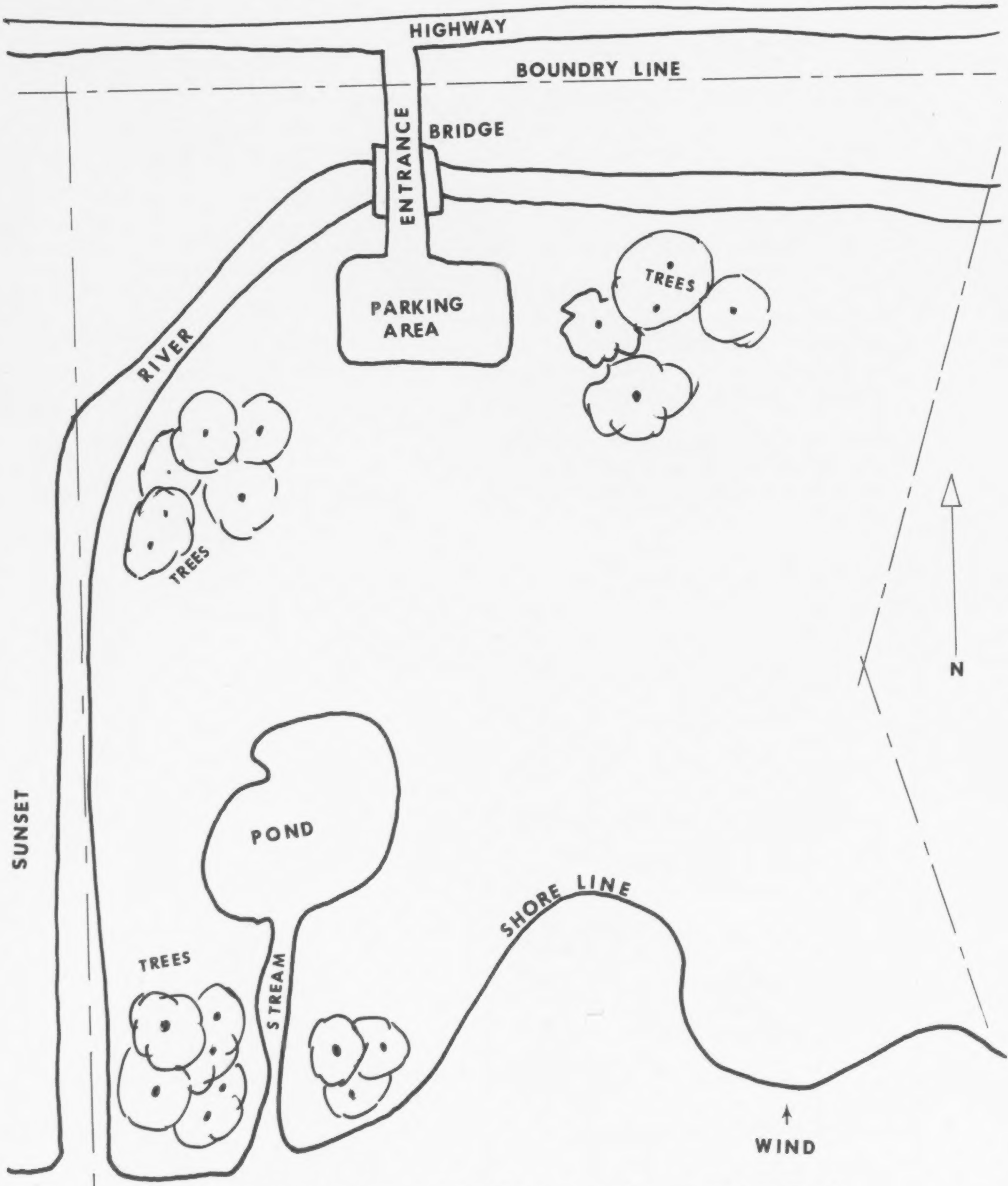
1. Figure 12A-1 is a site plan for a community park. Children, teenagers, and adults in the community will use it. Review the List of Beginning Ideas for Areas (Fig. 12A-2) and check those areas you would like to include in the park.
2. Review the List of Beginning Ideas for Structures (Fig. 12A-3) and check the structures you would like to include in the park.

## Sketching Park Areas

3. Lay a sheet of tracing paper over the site plan and paper clip it firmly in place.
4. Trace the two (2) register marks (+). *Do not trace the site plan.* Begin sketching beginning ideas from Fig. 12A-2 to show how you would use the park area. You can guess at the sizes of your areas by using the 100 unit scale in Fig. 12A-4. The parking area has already been sketched as an example. See Fig. 12A-1.
5. Sketch in the location of all of the park areas.

Fig. 12A-2. List of Beginning Ideas for Areas

| Check | Areas | Size |
|---|---|---|
| ______ | Children's playground equipment area:<br>swings, slides, sandboxes, jungle gym, merry-go-round, etc. | 100 Units X 100 Units |
| ______ | Sports and game courts area:<br>basketball, horseshoes, shuffleboard, croquet, etc. | 100 Units X 100 Units |
| ______ | Playfield areas:<br>baseball, softball, football, soccer, etc. | 200 Units X 200 Units |
| ______ | Swimming pool area:<br>(children, teenagers, adults) swimming, sunbathing | 100 Units X 100 Units |
| ______ | Parking area: (example: see site plan) | 80 Units X 130 Units |
| ______ | Picnic area: | 50 Units X 50 Units |
| ______ | Boat dock area: | 25 Units X 100 Units |
| ______ | Pond area: (around pond) | 25 Units X 100 Units |
| ______ | Other: | ___ Units X ___ Units |
| ______ | Other: | ___ Units X ___ Units |


HIGHWAY
BOUNDRY LINE
ENTRANCE
BRIDGE
PARKING AREA
TREES
RIVER
TREES
N
SUNSET
POND
SHORE LINE
TREES
STREAM
WIND

Lake Hope Site Plan for Community Park

0
100

SCALE: 100 yards (units)

Fig. 12A-1.

## Sketching Location of Structures

6. Now sketch in where you will locate the structures. Use the symbols in Fig. 12A-3. See Fig. 12A-5.

## Recording Ideas

7. Sketch several arrangements for the areas and structures.
8. When you are satisfied that you have the best arrangement of areas and structures add a few notes about construction materials and other factors such as: fences, benches, lighted area, etc. See Fig. 12A-5.
9. Print your name on all of your sketches and notes and paper clip them together. Hand them in when the teacher calls for them.

Fig. 12A-3. List of Beginning Ideas for Structures

| Check | Structures | Symbols |
|---|---|---|
| ______ | Refreshment stand | RS |
| ______ | Shower facilities | SF |
| ______ | Outdoor cooking facilities | OC |
| ______ | Bait house and boat rental | BB |
| ______ | Sports and playground equipment storage | E |
| ______ | Sheltered picnic area | SPA |
| ______ | Fountain and fish pond | FF |
| ______ | Drinking fountains | DF |
| ______ | Rest rooms | RR |
| ______ | Other______ | |
| ______ | Other______ | |

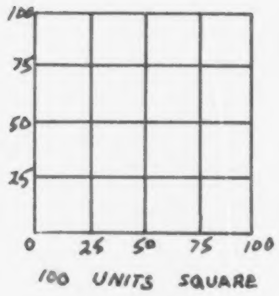


Fig. 12A-4. 100 Unit Scale

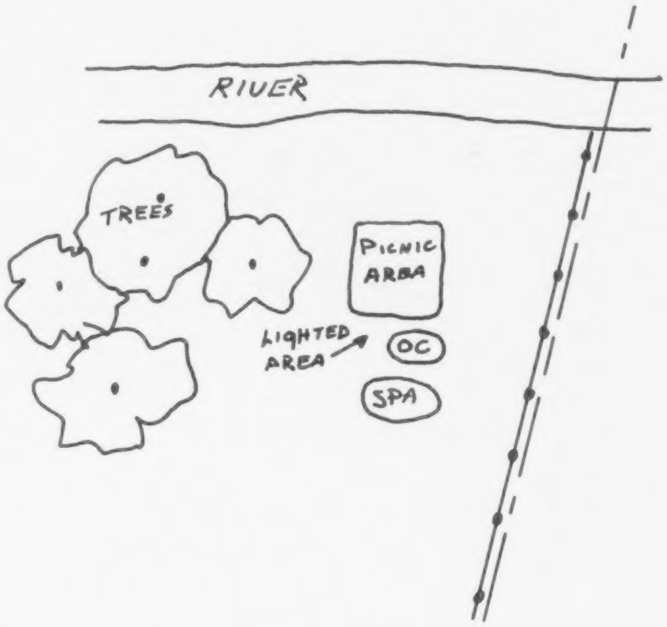


Fig. 12A-5. Sketching Areas and Structures

**ACTIVITY 12B**

# Developing Preliminary Ideas

## Problem

### Objective:

Given the problem of designing a community park, develop beginning ideas for one of the park areas or one of the structures.

**Supplies** (Each student)

3 pcs. 8½" x 11" tracing paper
1 paper clip

### Selecting an Area or Structure

1. Select one of the areas or structures from Fig. 12B-1 or Fig. 12B-2.

### Sketching Beginning Ideas

2. Paper clip a sheet of tracing paper over the grid sheet. See Fig. 12B-3. Trace the register marks (+).

| Spaces in Areas | Unit Sizes | |
|---|---|---|
| **Children's playground equipment area: 25 units x 25 units** | | |
| | **Width** | **Length** |
| Slide | 2 | 2 |
| Swing | 2 | 4 |
| Seesaw (teeter toter) | 2 | 2 |
| Sand box | 2 | 2 |
| Merry-go-round | 3 | 3 |
| Jungle gym | 2 | 2 |
| Other__________ | ______ | ______ |
| **Sports and game courts area: 25 units x 25 units** | | |
| Shuffleboard | 1 | 6 |
| Dodge ball | 6 | 6 |
| Hopscotch | 1 | 2 |
| 2 Tennis | 6 | 12 |
| Horseshoes | 1 | 5 |
| Croquet | 4 | 8 |
| 2 Basketball | 5 | 10 |
| Other__________ | ______ | ______ |
| **Playfield area: 25 units x 25 units** | | |
| Softball | 3 | 3 diamond |
| Hardball | 4 | 4 diamond |
| Little League Ball | 3 | 3 diamond |
| Football | 6 | 12 diamond |
| Soccer | 8 | 13 |
| Other__________ | ______ | ______ |
| **Swimming Pool area: 25 units x 25 units** | | |
| Children only pool | 3 | 8 |
| Adults only pool | 5 | 10 |
| Children and adults pool | 6 | 12 |
| Sun bathing | 6 | 12 |
| Observation area (around each area) | 1 | 10 |
| Other__________ | ______ | ______ |
| **Picnic area: 25 units x 25 units** | | |
| 20 Tables | 1 | 1 |
| 5 Outdoor ovens | 1 | 1 |
| 5 Garbage containers | 1 | 1 |
| 2 Wash and water units | 1 | 1 |
| Other__________ | ______ | ______ |
| **Boat dock area: 10 units x 40 units** | | |
| 1 Driveway (2 lanes) | 1 | 40 |
| 1 Turn-around circle | | 3 dia. |
| 6 Boat docks | 1 | 4 |
| 6 Boat berths | 4 | 4 |
| 1 Fuel dock | 5 | 5 |
| 1 Boat ramp | 4 | 4 |
| 1 Parking | 4 | 20 |
| Other__________ | ______ | ______ |
| **Pond area: 10 units x 40 units** | | |
| 20 Benches | 1 | 2 |
| Walks and trails | 1 | 30 |
| 3 Fishing piers | 1 | 3 |
| Fountains | 3 | 3 |
| 3 Flower gardens | 2 | 5 |
| 3 Drinking fountains | 1 | 1 |
| Other__________ | ______ | ______ |

Fig. 12B-1. List of Preliminary Ideas for Areas

Fig. 12B-2. List of Preliminary Ideas for Structures

| | Space in Structure | Unit Sizes | |
|---|---|---|---|
| **Symbol** | | **Width** | **Length** |
| RS | Refreshment stand: 15 units x 25 units | | |
| | Storage room (supplies) | 3 | 4 |
| | Food service room | 10 | 15 |
| | Utility room (water heater, furnace, air conditioning) | 3 | 4 |
| | Equipment space | 4 | 4 |
| | 2 Rest rooms | 3 | 4 |
| | Halls or passageways | 3–4 | |
| | Other__________________ | ______ | ______ |
| SF | Shower facilities: 20 units x 25 units | | |
| | 2 Locker rooms | 10 | 15 |
| | 2 Shower rooms | | 5 |
| | 2 Rest rooms | 3 | 4 |
| | Halls or passageways | 3–4 | |
| | Other__________________ | ______ | ______ |
| BB | Bait house and boat rental: 20 units x 25 units | | |
| | 2 Rest rooms | 5 | 5 |
| | Equipment supply and rental area | 15 | 15 |
| | Bait room | 10 | 10 |
| | Utility room (water heater, furnace, air conditioning) | 5 | 5 |
| | Halls or passageways | 3–4 | |
| | Other__________________ | ______ | ______ |
| E | Sports and playground equipment storage: 15 units x 20 units | | |
| | Light equipment room | 10 | 15 |
| | Storage area | 5 | 5 |
| | Halls or passageways | 3–4 | |
| | Other__________________ | ______ | ______ |
| SPA | Sheltered Picnic area: 25 units x 25 units | | |
| | 20 Tables | 1 | 3 |
| | Wash up area | 3 | 5 |
| | Garbage disposal | 3 | 5 |
| | Stage (platform) | 5 | 15 |
| | 2 Rest rooms | 5 | 5 |
| | Other__________________ | ______ | ______ |
| FF | Fountain and fish pond: 25 units x 25 units | | |
| | Pool outside | 15 | 15 |
| | Pool island | 10 | 10 |
| | 10 Benches (sitting areas) | 2 | 3 |
| | 3 Landscaped gardens | 3 | 10 |
| | Paths | 2–3 | |
| | Other__________________ | ______ | ______ |

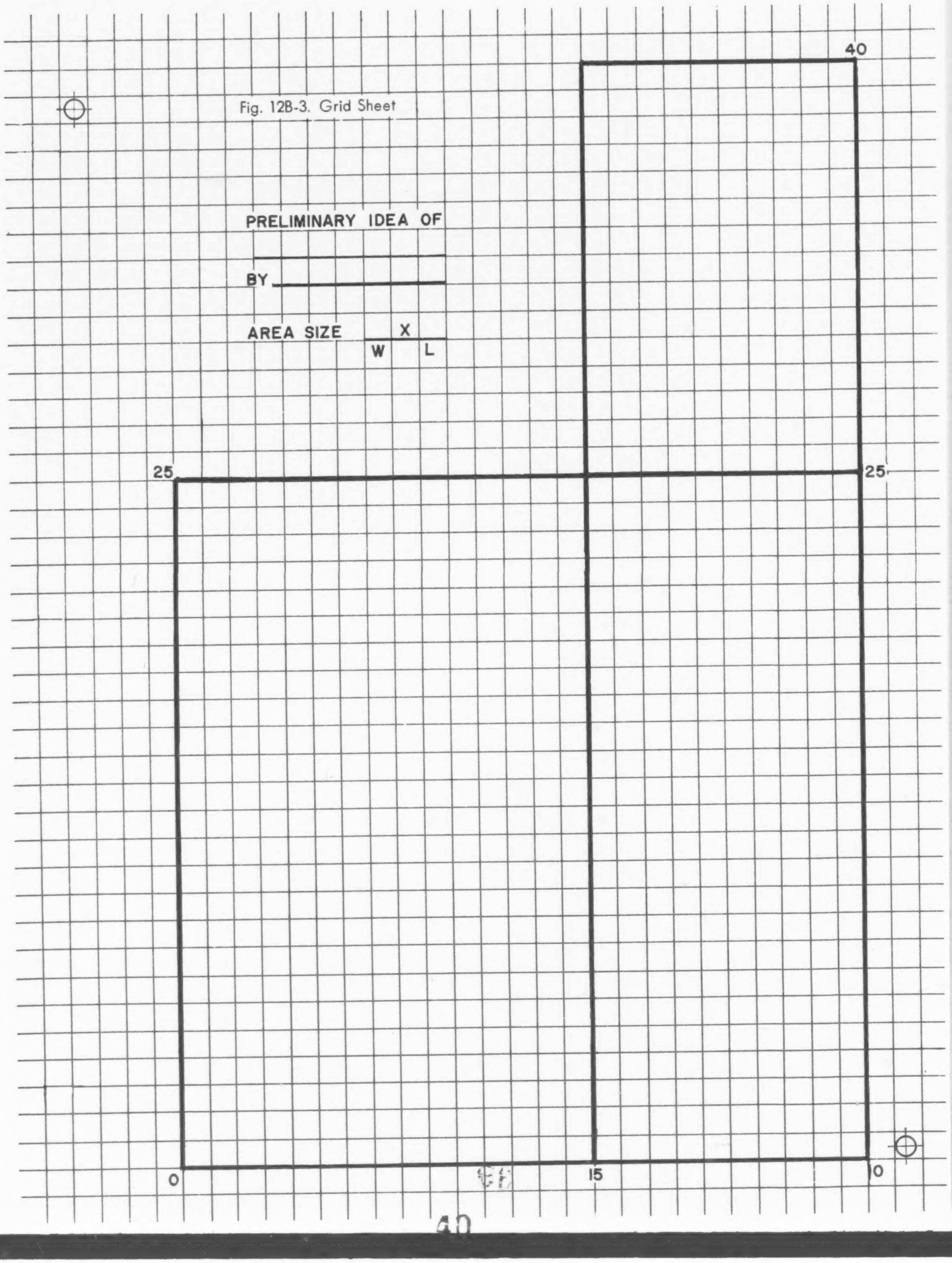

40
25
25
0
15
0

Fig. 12B-3. Grid Sheet

PRELIMINARY IDEA OF

BY

AREA SIZE ____ X ____
W L

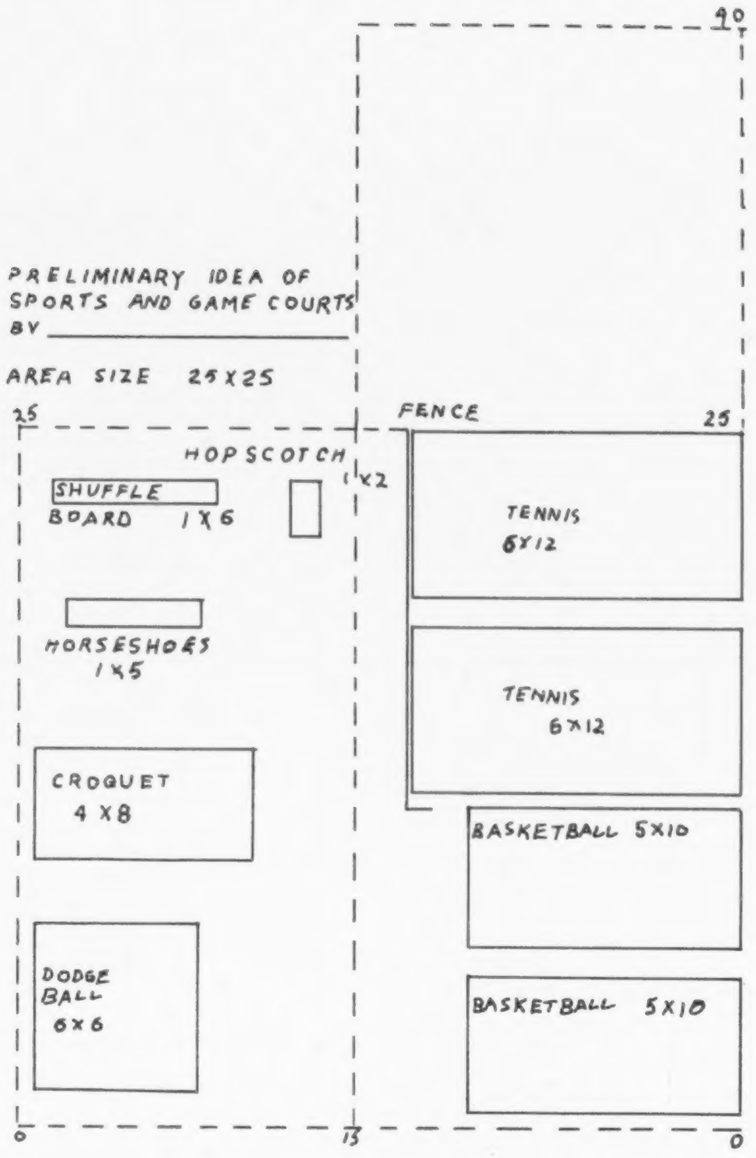

PRELIMINARY IDEA OF
SPORTS AND GAME COURTS
BY ____
AREA SIZE 25X25
40
25
FENCE
25
HOPSCOTCH
1X2
SHUFFLE BOARD 1X6
TENNIS 6X12
HORSESHOES 1X5
TENNIS 6X12
CROQUET 4X8
BASKETBALL 5X10
DODGE BALL 6X6
BASKETBALL 5X10
0
15
0

Fig. 12B-4. Example Area

3. Record the name of the area or structure you will sketch on the blank line under "Preliminary Idea of." Print your name on the next blank line. Record the area size (unit width and length). On the grid sheet, draw a line around the area you will be designing in.

4. Select one area or structure to develop from Fig. 12B-1 or Fig. 12B-2.

## Developing Ideas

5. Think how you can arrange those spaces on the tracing paper. Start counting out the unit sizes for each space and draw a line around the area. Print in the name and size of the space. See Fig. 12B-4 and Fig. 12B-5.
6. If you are not satisfied with your arrangement try another arrangement on another piece of tracing paper.

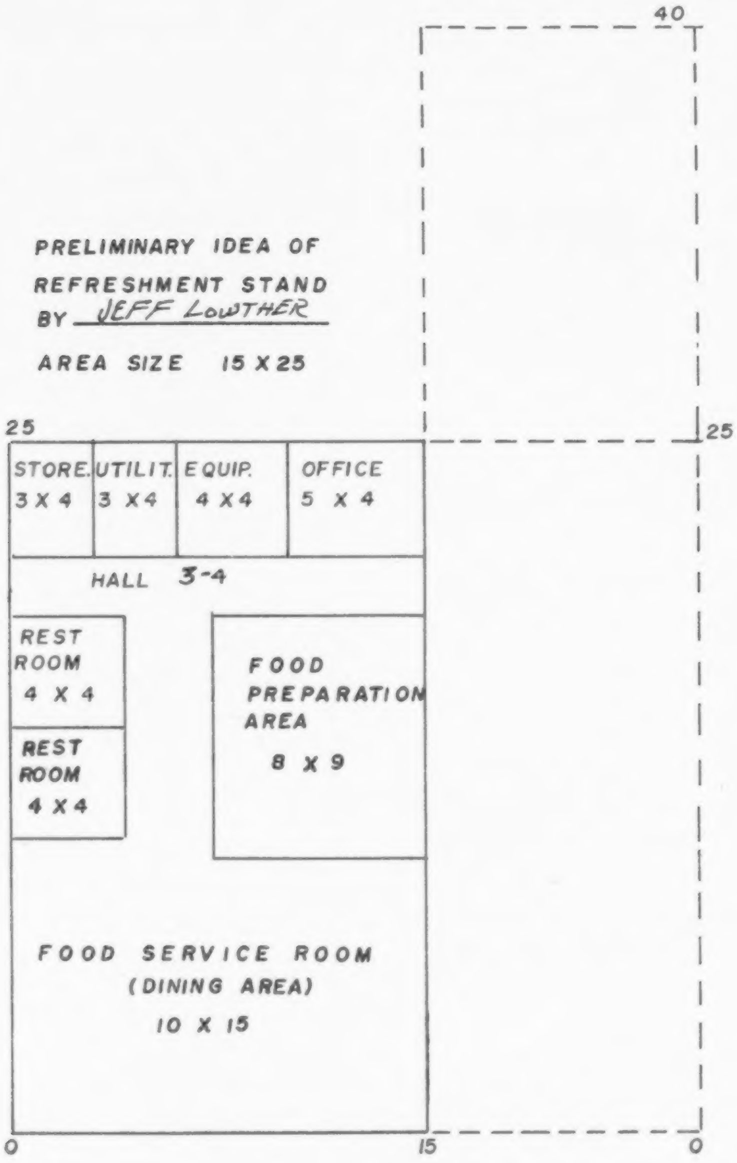

40
PRELIMINARY IDEA OF
REFRESHMENT STAND
BY JEFF LOWTHER
AREA SIZE 15 X 25
25
25
STORE. 3 X 4
UTILIT. 3 X 4
EQUIP. 4 X 4
OFFICE 5 X 4
HALL 3-4
REST ROOM 4 X 4
REST ROOM 4 X 4
FOOD PREPARATION AREA 8 X 9
FOOD SERVICE ROOM (DINING AREA) 10 X 15
0
15
0

Fig. 12B-5. Example Structure

**ACTIVITY 13A**

# Refining Ideas

You will be improving your beginning ideas for the location of areas and structures.

**Problem**

### Objective:

Using a list of design requirements for the park areas and structures:

a. Draw an improved sketch of the location of structures.

b. Plan the walkways to connect the areas.

**Supplies** (Each student)

| | |
|---|---|
| | all preliminary sketches from Activity 12A |
| 2 pcs. | 8½" x 11" tracing paper |
| 2 | paper clips |
| 1 | 12" rule |

### Reading Design Requirements

1. Figure 13A-1 and Fig. 13A-2 give you the design requirements to guide you in refining the park areas and structures. Study both figures.
2. Paper clip the tracing paper over the Site Plan, Fig. 13A-3. Trace the register marks (+).

### Refining Ideas of Areas

3. Refer to the sketches you made in Activity 12A and decide what areas (Fig. 13A-1) need to be changed to meet the design requirements.
4. Sketch in the new locations. Estimate the proportions from the 100 unit scale on the site plan and from Fig. 13A-1 and Fig. 13A-2.

### Refining Ideas of Structures

5. Refer to the sketches you made in Activity 12A and decide what structures (Fig. 13A-2) need to be changed in location to meet the design requirements. See Fig. 13A-4.
6. Mark the new locations with the symbols given in Fig. 13A-2.
7. Have the teacher approve your sketch before going on.

### Adjusting Design

8. If your sketch does not meet the design

Fig. 13A-1. Design Requirements for the Location of Areas

**Children's Playground Equipment Area:** 100 units x 100 units
Children's play areas must not be within 50 units of a river, pond, stream, lake, or highway.

**Sports and Games Area:** 100 units x 100 units
Court areas should not be located under trees, or within 50 units of the parking area.

**Playfield Areas:** 200 units x 200 units
Playfield area cannot be located within 100 units of river, lake, pond, or stream.

**Swimming Pool Area:** 100 units x 100 units
Pools should not be located within 50 units of trees.

**Boat Dock Area:** 25 units x 100 units
Boat docks should not be located within 50 units of river, or stream. There must be a road from the parking lot to the boat dock area.

**Picnic Area:** 50 units x 50 units
No restrictions or requirements.

**Pond Area:** 25 units x 100 units
Should circle around the pond.

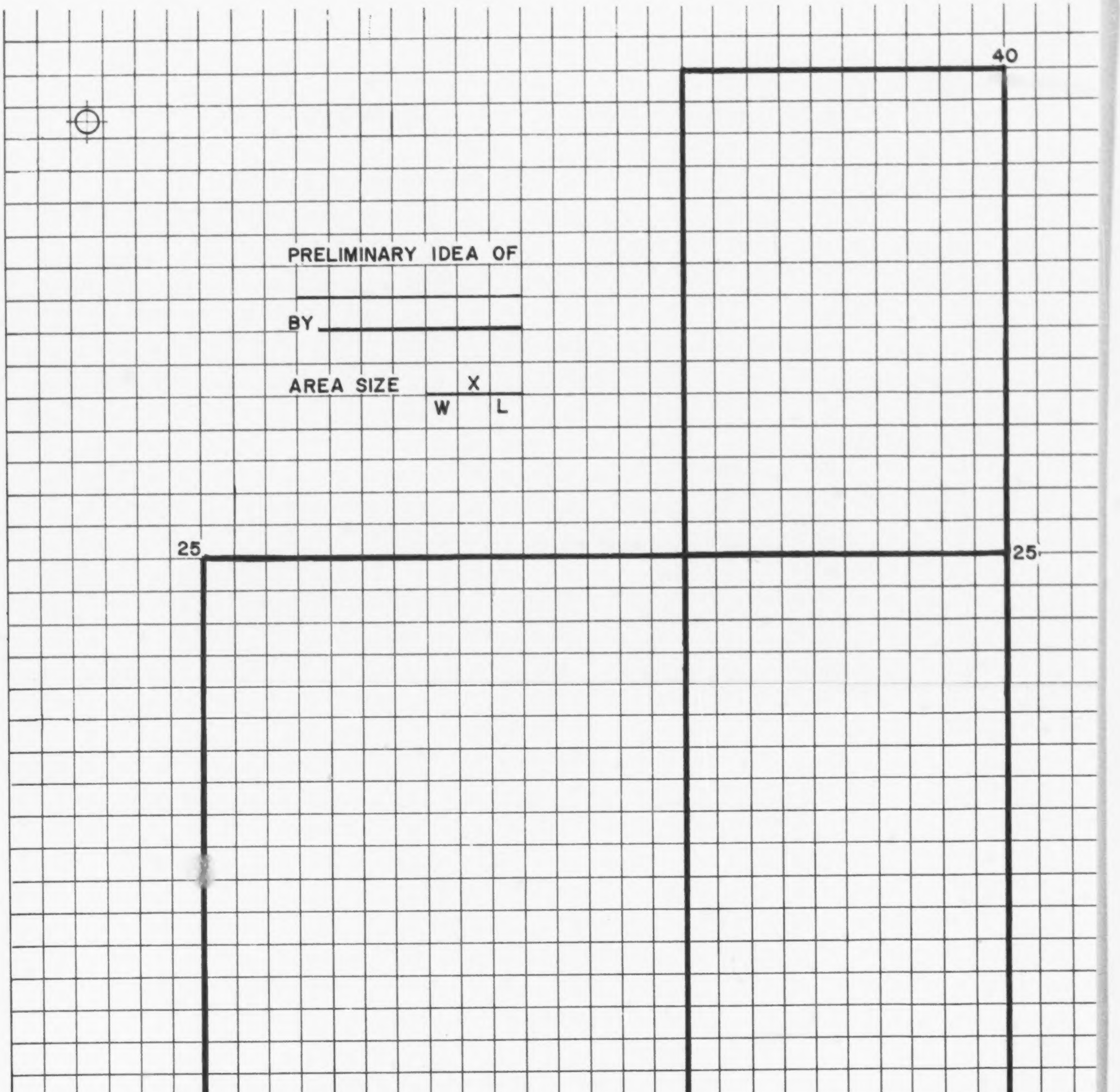

PRELIMINARY IDEA OF
BY
AREA SIZE
X
W
L
40
25
25
0
15
0

Fig. 13A-3.

Fig. 13A-2. Design Requirements for the Location of Structures

RS **Refreshment stand**
No restrictions or requirements

BB **Bait House and Boat Rental**
Within 50 units of boat docks

E **Sports and Playground Equipment Storage**
Centrally located to playground, playfields and courts

DF **Drinking Fountains**
Located next to or in each area

RR **Restrooms**
Centrally located in park

SF **Shower facilities**
Located within 25 units of playfields, playground and courts

SPA **Sheltered Picnic Area**
No restrictions or requirements

OC **Outdoor Cooling Facilities**
Located within 50 units of sheltered picnic area

requirements, you will need to rework it.

## Sketching Traffic Flow

9. After the teacher approves your sketch, draw paths or walkways to connect all of the areas listed in Fig. 13A-1. The path may be curved or straight. Draw two lines very close together for the path. See Fig. 13A-4.
10. Print your name on the tracings and hand them in when the teacher calls for them.

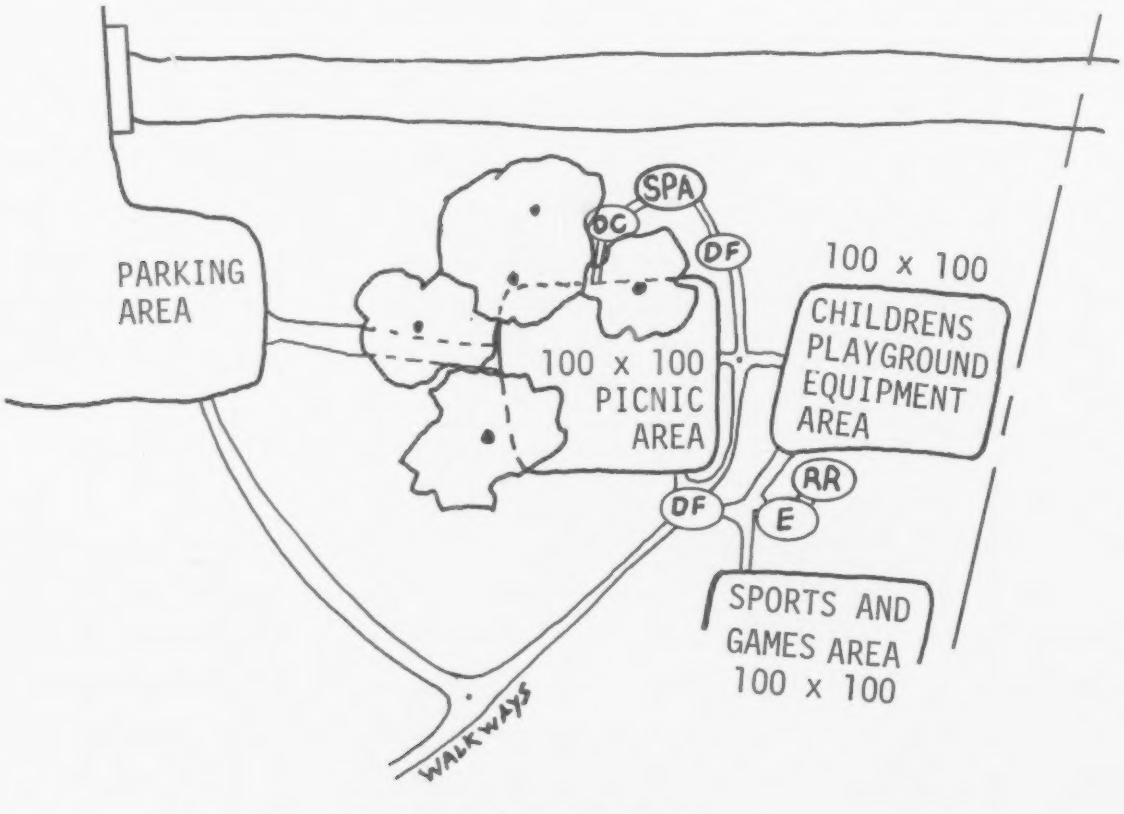

SPA
OC
DF
100 x 100
CHILDRENS PLAYGROUND EQUIPMENT AREA
PARKING AREA
100 x 100 PICNIC AREA
RR
DF
E
SPORTS AND GAMES AREA 100 x 100
WALKWAYS

Fig. 13A-4. Example Refined Area

**ACTIVITY 13B**

# Refining Ideas

You will be improving your beginning ideas for the further development of the area or structure you have selected in Activity 12B.

**Problem 1**

## Objective:

Using a list of design requirements for the park areas and structures:

a. Draw a refined sketch of an area, *or*
b. Draw a refined sketch of a structure.

**Supplies** (Each student)

all preliminary sketches from
Activity 12B
2 pcs. 8½" x 11" tracing paper
2 paper clips

## Reading Design Requirements

1. Figure 13B-1 and Fig. 13B-2 give you the design requirements to guide you in refining the park areas and structures. Select the area or structure you developed in Activity 12B and read the design requirements for it.
2. Paper clip the tracing paper over the ¼" Grid Sheet, Fig. 13B-3. Trace the register marks (+).

Fig. 13B-1. Design Requirements for Refining Park Areas

**Children's Playground Equipment Area:** 25 units x 25 units
**Sports and Game Courts Area:** 25 units x 25 units
**Picnic Area:** 25 units x 25 units
**Pond Area:** 10 units x 40 units

All of the above areas have the following requirements:

1. No piece of equipment or area should be within 2 units of another.
2. There should be a path connecting each area or piece of equipment.
3. There should be at least 6 trees in the area and 6 benches.
4. A drinking fountain should be centrally located.
5. Add any details and notes that will help show your idea.

**Playfield Area:** 25 units x 25 units

1. Diamonds must face away from each other if they are within 10 units of each other.
2. There must be at least 2 benches for each diamond.
3. There should be backstops for each diamond.
4. There should be at least 6 trees in the area.
5. There must be at least 2 drinking fountains in the area.

**Boat Dock Area:** 10 units x 40 units

1. Driveway cannot be closer than 10 units to the water.

2. Driveway must provide access to fuel dock.
3. Boat ramp should be next to the fuel dock.
4. There should be at least 6 trees in the area.
5. A drinking fountain should be centrally located.
6. There should be a bait house and boat rental building in the area.

**Swimming Pool Area:** 25 units x 25 units

1. There should be at least 1 path connecting each area.
2. There should be a fence around each pool area.
3. There should be a bathhouse or shower facilities (2 units x 5 units) centrally located in the area.
4. There should be at least 10 trees in the area.
5. There should be benches near each pool.
6. There should be a refreshment stand (5 units x 5 units) centrally located in the swimming area. Shower facilities and refreshment stand can be combined into one building 6 units x 6 units.

Fig. 13B-2. Design Requirements for Refining Park Structures

1. All spaces between 10 units and 15 units within the design area can be increased or decreased by no more than 3 units to help the design arrangements.
2. All spaces less than 10 units can be increased or decreased by no more than 1 unit to help the design arrangement.
3. Indicate doors as 2 units wide and windows as 2 to 4 units wide if your structure is a building.
4. Add any details or notes that will help show your ideas.

## Refining Ideas

3. Refer to the sketches you made in Activity 12A and decide what changes are needed to meet the design requirements.
4. Sketch in the new space arrangements and requirements. See Fig. 13B-4 and Fig. 13B-5.

## Approving the Ideas

5. Have the teacher approve your sketch. If your sketch does not meet the design requirements you will need to rework it.
6. When you are satisfied with the refined sketch, print your name, the name of the area or structure, and size of the area or structure on the tracing. Hand in your sketches when the teacher calls for them.

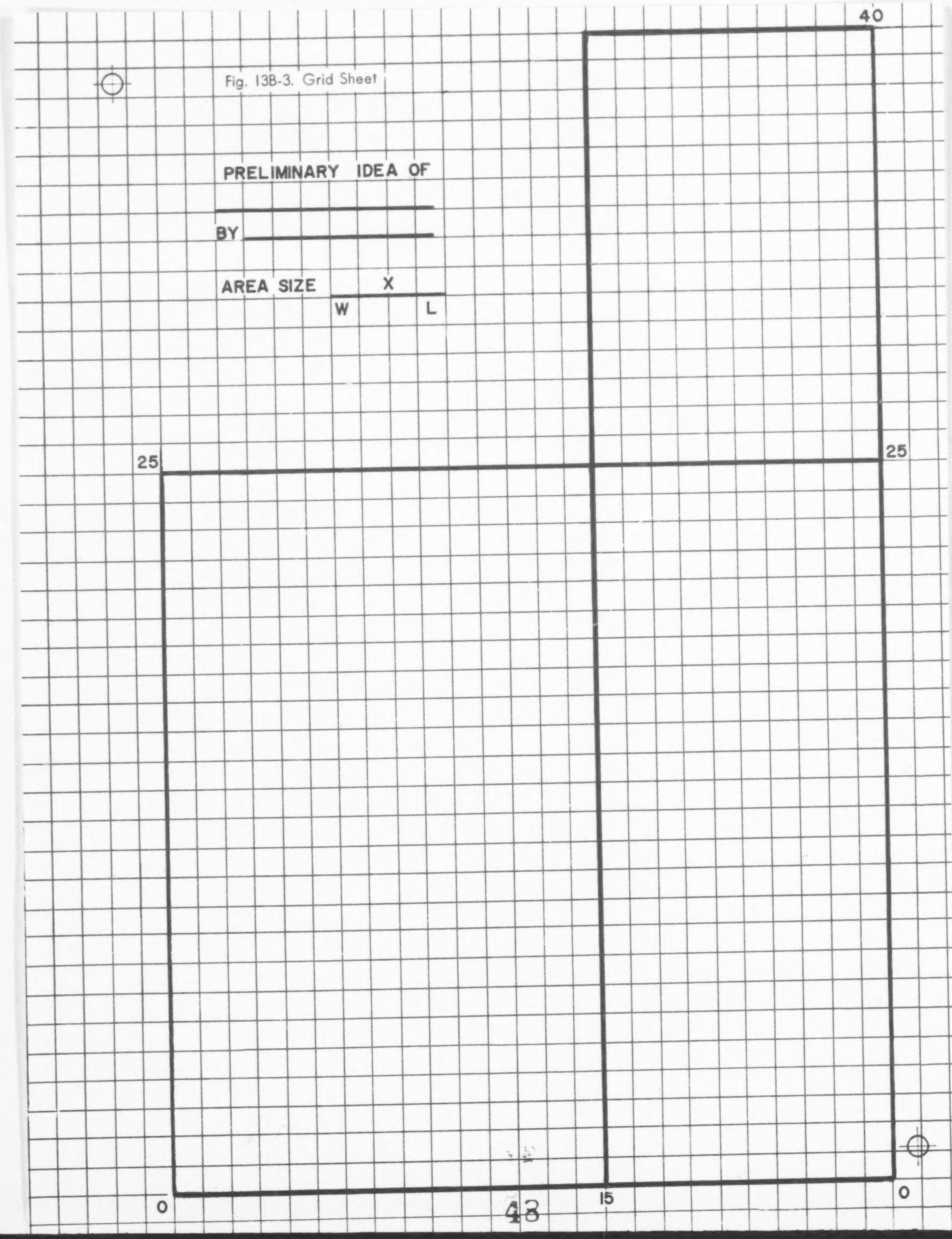

40
25
25
0
15
0

Fig. 13B-3. Grid Sheet

**PRELIMINARY IDEA OF**

________________________

**BY** ______________________

**AREA SIZE** _____ **X** _____
**W** **L**

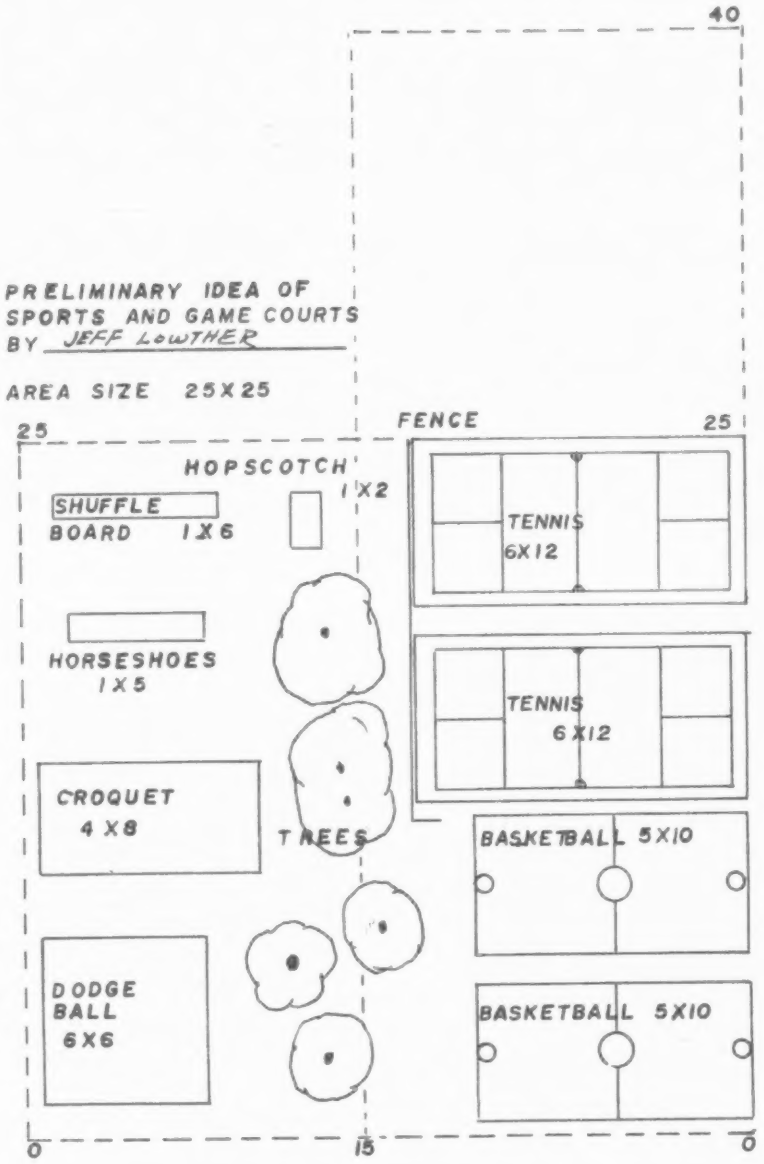

PRELIMINARY IDEA OF
SPORTS AND GAME COURTS
BY JEFF LOWTHER
AREA SIZE 25X25
40
25
FENCE
25
HOPSCOTCH
1X2
SHUFFLE BOARD 1X6
HORSESHOES 1X5
CROQUET 4X8
TREES
DODGE BALL 6X6
TENNIS 6X12
TENNIS 6X12
BASKETBALL 5X10
BASKETBALL 5X10
0
15
0

Fig. 13B-4. Example Refined Area

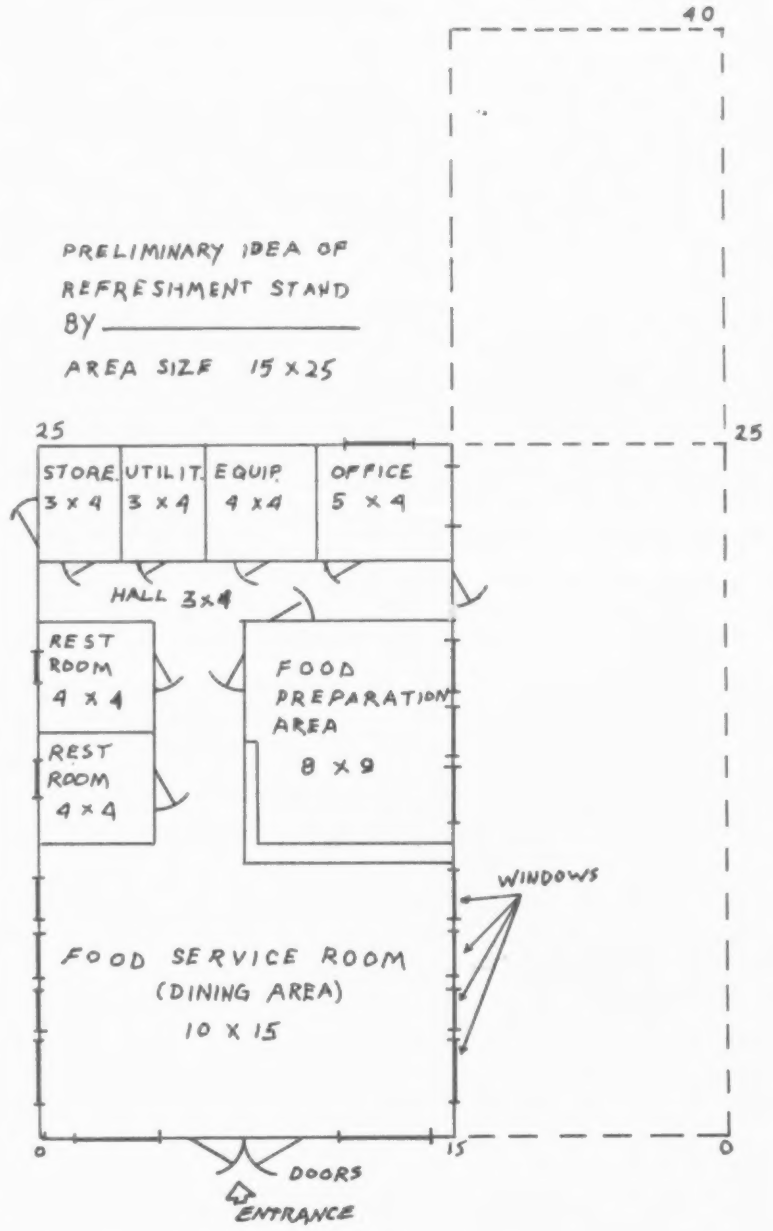

40
PRELIMINARY IDEA OF
REFRESHMENT STAND
BY
AREA SIZE 15 x 25
25
25
STORE 3 x 4
UTILIT. 3 x 4
EQUIP. 4 x 4
OFFICE 5 x 4
HALL 3x4
REST ROOM 4 x 4
REST ROOM 4 x 4
FOOD PREPARATION AREA 8 x 9
WINDOWS
FOOD SERVICE ROOM (DINING AREA) 10 x 15
0
15
0
DOORS
ENTRANCE

Fig. 13B-5. Example Refined Structure

**ACTIVITY 14A**

# Analyzing the Design

As a structural engineer you have been assigned to find the counterbalance weight needed for a bascule bridge.

**Problem**

### Objective:

Given the span dimensions of a bascule bridge and the location of the bridge's pivot point:

a. Figure the weight needed to counterbalance a load on the bridge.
b. Test your figures by constructing and counterbalancing a simple bascule bridge.

**Equipment** (Group of 5)
1 12″ rule

**Supplies** (Class)
36 bricks
1 2″ x 4″ x 3′4″ wood
2 2″ x 4″ x 4′ wood
2 2″ x 4″ x 8′ wood
5 1″ x 4″ x 1′ wood

### Figuring Counterbalance Weight

1. A bascule bridge is to be built across the river at the entrance to the Community Park. Your teacher will assign each group one problem from Fig. 14A-1, Bridge Span Data.
2. Using the number values in Fig. 14A-1, each group member is to figure the counterbalance weight needed for the span assigned your group.

   Use the formula:

   $$W \text{ (weight)} = \frac{V \text{ (vehicle weight)} \times C}{B}$$

   See Figure 14A-1.
3. Study the Procedure for Figuring

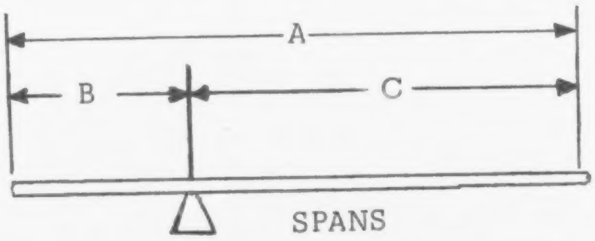


Fig. 14A-1. Bridge Span Data

| Problem Number | Total Span in units of weight A | Short Span in units of length B | Long Span in units of length C | Vehicle Load at Z, in units of weight V | Counterbalance Load at X, in units of weight W |
|---|---|---|---|---|---|
| 0 | 9 | 3 | 6 | 1 | 2 |
| 1 | 8 | 2 | 6 | 1 | ——— |
| 2 | 12 | 3 | 9 | 1 | ——— |
| 3 | 12 | 4 | 8 | 1 | ——— |
| 4 | 24 | 6 | 18 | 1 | ——— |
| 5 | 24 | 8 | 16 | 1 | ——— |

Bridge Counterbalance Weight (Fig. 14A-2). Do the arithmetic for your problem in the column labeled "Your Problem."

4. Check your answer with the other engineers in your group to see if it is the same.

Fig. 14A-2. Procedure for Figuring Bridge Counterbalance Weight

| Problem O (Example) | Your Problem |
|---|---|
| Formula $W = \frac{V \times C}{B}$ | $W = \frac{V \times C}{B}$ |
| Substitute $W = \frac{1 \times 6}{3}$ | $W = \frac{\quad x \quad}{\phantom{x}}$ |
| Multiply $W = \frac{6}{3}$ | $W =$ _____ |
| Divide $W = \frac{6}{3}$ | $W =$ _____ |
| Answer $W = 2$ | $W =$ _____ |

## Testing the Figures

5. Gather the equipment and supplies for the problem assigned your group (see Fig. 14A-3).

Fig. 14A-3. Equipment and Supplies

| Problem Number | 2″ x 4″ | 1″x4″x12″ | 12″ rule | bricks |
|---|---|---|---|---|
| 1 | 40″ | 1 | 1 | 8 |
| 2,3 | 4′ | 1 | 1 | 6 |
| 4,5 | 8′ | 1 | 1 | 8 |

6. Measure and mark the following span unit lengths for your problem. See Fig. 14A-4.

Fig. 14A-4. Span Unit Lengths

| Problem | B | C | A |
|---|---|---|---|
| 1 | 10″ | 30″ | 3′ 4″ |
| 2 | 12″ | 36″ | 4′ |
| 3 | 16″ | 32″ | 4′ |
| 4 | 24″ | 72″ | 8′ |
| 5 | 32″ | 64″ | 8′ |

7. Balance your bridge at the pivot point. See Fig. 14A-5. Move the brick(s) back and forth until the bridge balances.

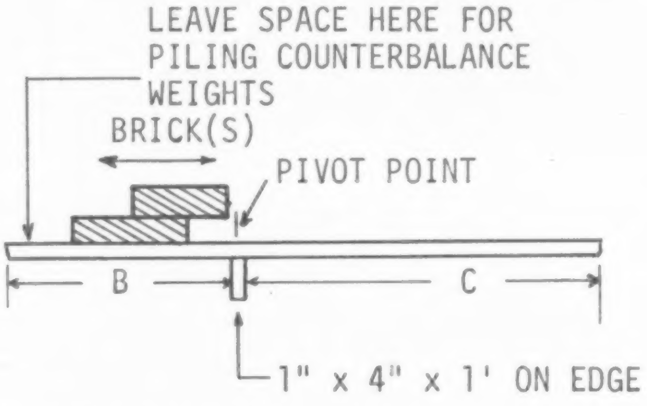


Fig. 14A-5. Bridge Balance Diagram

8. Add the vehicle load (brick) at end Z. See Fig. 14A-6.

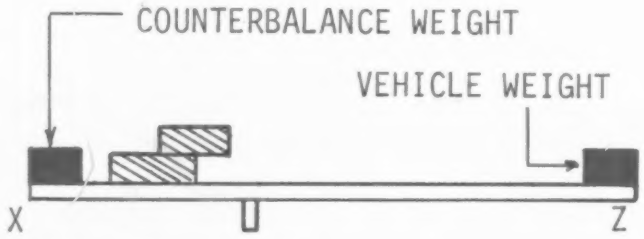


Fig. 14A-6. Placement of Weights

9. Add the number of counterbalance unit weights you figured at end X. See Fig. 14A-6.
10. Be sure the bricks are even with the ends at points "X" and "Z."
11. Did your bridge balance as you figured it would? (Yes/No)

**ACTIVITY 14B**

# Analyzing the Design

As a civil engineer you have been assigned to find the grade limit for a roadway in the community park.

**Problem 1**

## Objective:

Given the weight of a vehicle in tons and the pounds of engine pull, figure the grade limit for roadways made of concrete or blacktop, gravel and sand.

## Figuring Pounds of Engine Pull Per Ton of Weight

1. Your group foreman will assign each member one of the following types of roadways in Fig. 14B-1: (1) Concrete or Blacktop, (2) Gravel, or (3) Sand.
2. To solve your roadway problem, enter the figures for pounds of engine pull and tons of weight for each kind of vehicle shown in Fig. 14B-1 in Fig. 14B-2.

Fig. 14B-1. Engine Pull Efficiency

| | | Pounds of Engine Pull | | |
|---|---|---|---|---|
| Vehicle | Vehicle Weight in Tons | Concrete or Blacktop | Gravel Topped | Sand |
| Automobile | 2,000 | 3,520 | 3,470 | 3,400 |
| Automobile, Boat & Trailer | 4,000 | 3,440 | 3,340 | 3,200 |
| Truck | 5,000 | 8,800 | 8,675 | 8,500 |

Fig. 14B-2. Figuring Engine Pull Per Ton of Weight

| Vehicle | Type of Roadway: ____________ | Grade Limits |
|---|---|---|
| Automobile | ____ pounds of engine pull<br>____________ = ____ pounds of engine pull<br>____ tons of weight per ton of weight | ______ |
| Automobile, Boat & Trailer | ____ pounds of engine pull<br>____________ = ____ pounds of engine pull<br>____ tons of weight per ton of weight | ______ |
| Truck | ____ pounds of engine pull<br>____________ = ____ pounds of engine pull<br>____ tons of weight per ton of weight | ______ |

3. Divide tons of weight into pounds of engine pull. Your answer will be pounds of engine pull per ton of weight. Find this answer for all three vehicles.

## Determining Grade Limit

4. Figure 14B-3 is a Grade Limit Graph. Along the left edge locate your first answer: pounds of engine pull per ton of weight for an automobile. Run your pencil across to the diagonal line, then straight down. What is the grade limit for the automobile? Enter the grade limit in Fig. 14B-2.
5. Repeat step 4 for each vehicle.
6. What is the grade limit for your roadway? (What is the smallest or least steep grade you found?) _____%

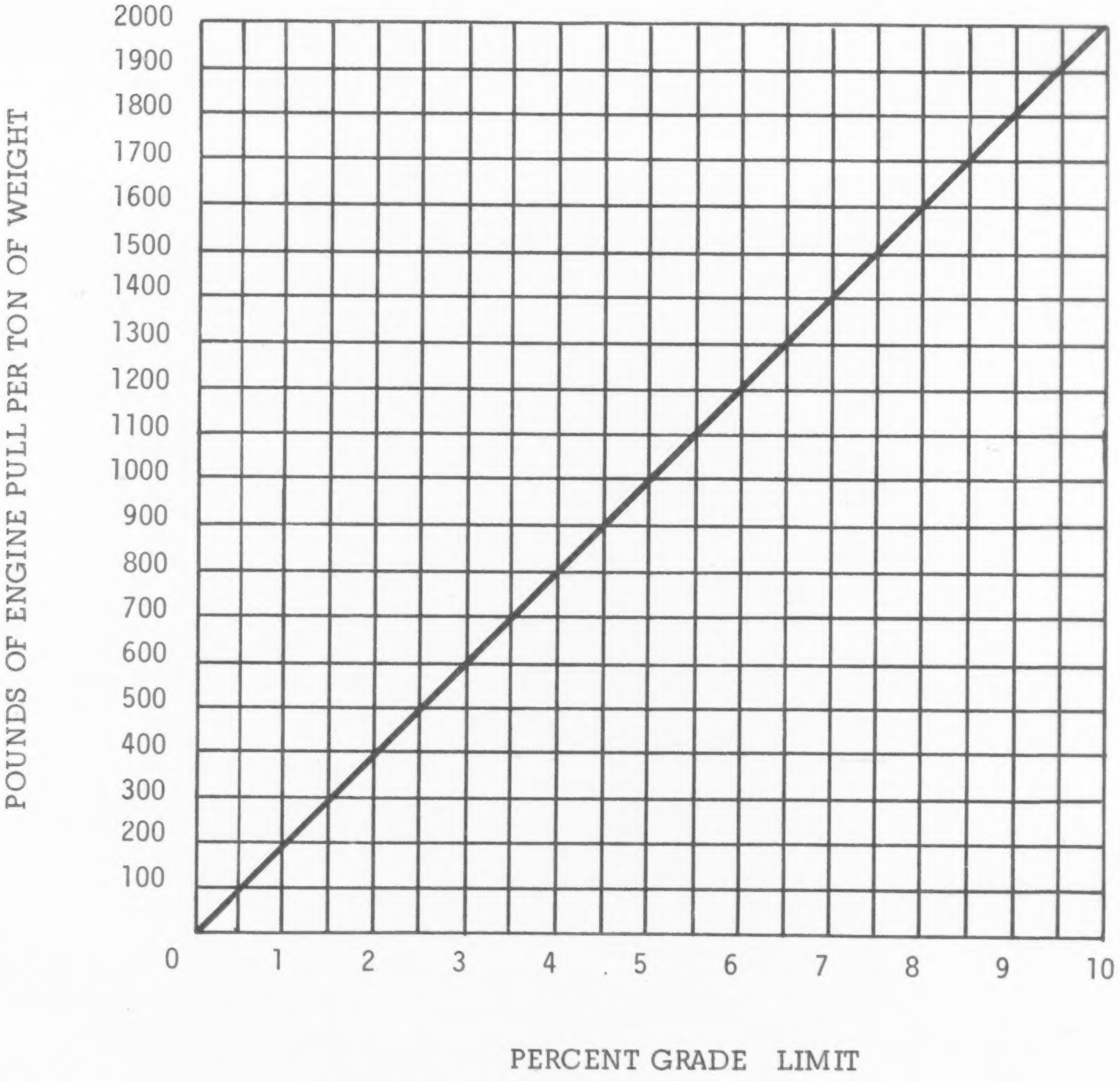


Fig. 14B-3. Grade Limit Graph

**Problem 2**

## Objective:

Using the grade limit of a roadway, construct a simple roadway and test the figures for the grade limit.

**Supplies** (Group of 5)

1 1″ of a 2″ dia. pipe (approx. sizes)
1 pc. 1″ x 2″ x 24″ lumber
1 pc. 1″ x 2″ x 3″ block of wood
1 pc. thread 24″ long
1/5 box paper clips
1 pc. 3″ masking tape

**Equipment** (Group of 5)

1 pr. side cutter pliers
1 try square

## Preparing the Roadway

1. From one end of the 24″ board, measure and mark the following lengths: 4″, 6″ and 7⅜″ on the edge and face of the board. On the face of the board, print 3%, 4%, and 5%. See Fig. 14B-4.
2. Bend and tape a paper clip at the end of the board to form a yoke. Cut another paper clip and center it on the 6″ line. See Fig. 14B-4.
3. Tape one end of the thread in the center of the ring. Attach a paper clip to the other end of the thread. Open one end of another paper clip and tape it to the side of the ring. See Fig. 14B-5.

## Balancing the Vehicle

4. Set the 1″ x 2″ x 3″ block under the roadbed at the 4% incline mark. See Fig. 14B-6. Center the ring weight (which represents the weight of the vehicle) on the 6″ line and paper clip. Lay the thread over the yoke and let it hang freely over the edge of the table. See Fig. 14B-7. Adjust the yoke if the thread catches on the wood.
5. Hold the ring in place while another student adds paper clip counterbalance weights to the free end until the paper clip indicator remains stationary. The ring is properly balanced when the indicator is pointing straight up.

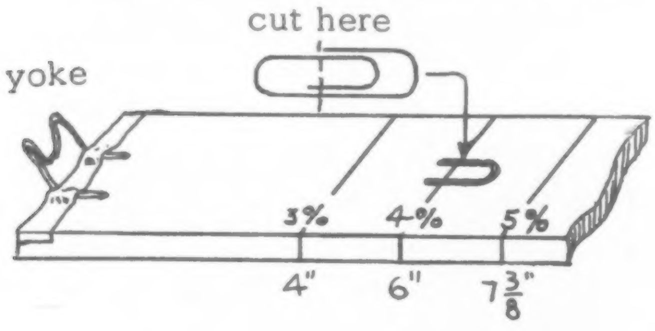


Fig. 14B-4. Roadway Layout and Yoke Assembly

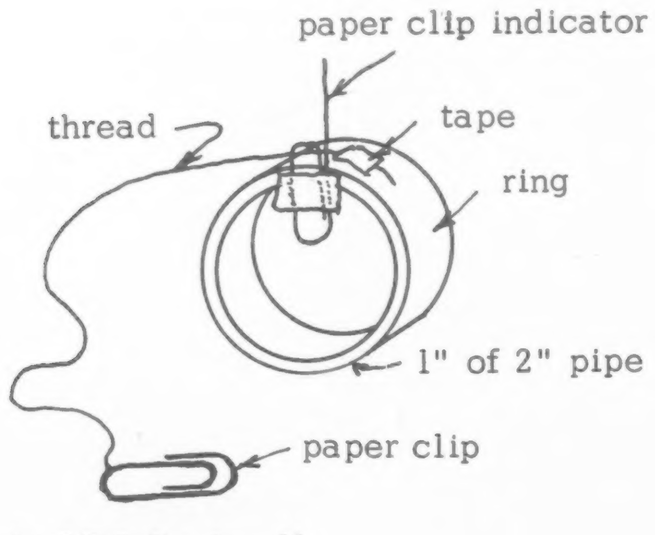


Fig. 14B-5. Ring Assembly

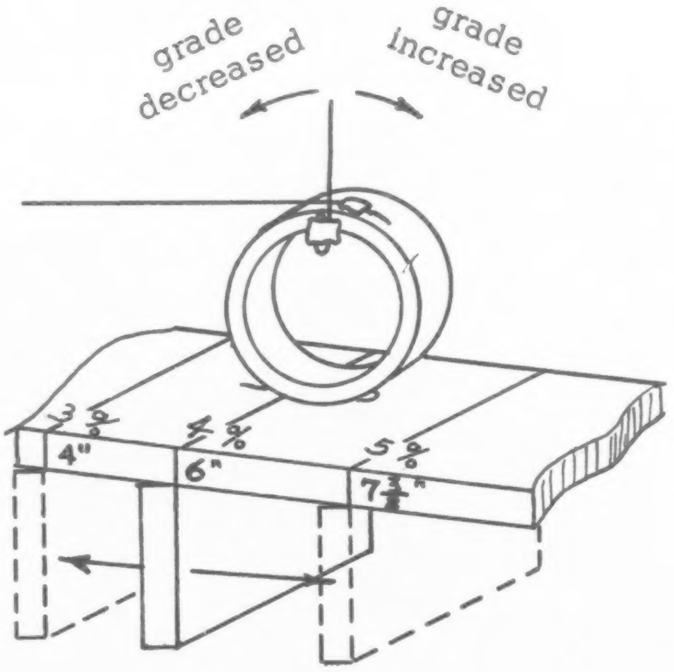


Fig. 14B-6. Checking Grade Limits

## Testing Grade Limit Figures

6. You found from your figures that the required grade limit is approximately 4%. You have just balanced the vehicle at the maximum grade limit. Therefore, if the grade is reduced to 3%, the vehicle should roll forward toward the yoke. If the grade is increased, the vehicle should roll backward. It cannot climb the hill because of its engine pull and weight.

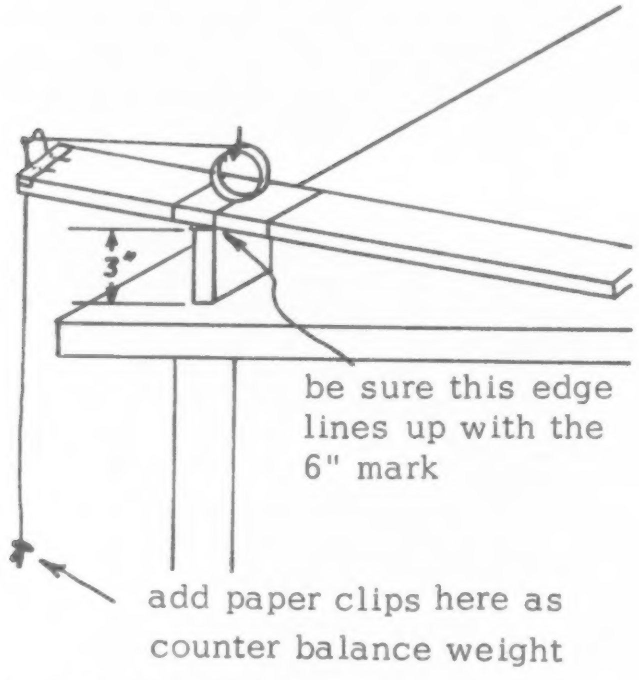

3"
be sure this edge lines up with the 6" mark
add paper clips here as counter balance weight

Fig. 14B-7. Roadway Test Assembly

7. Press lightly on the low end of the board to keep it from moving. Carefully slide the block to the 3% grade mark. See Fig. 14B-6. Watch the indicator. It should move slightly counterclockwise. Tap on the board lightly.
8. Reset the ring and block on the 4% grade and carefully slide the block to the 5% grade mark. The indicator should move clockwise. Tap on the board lightly.
9. If the indicator did not move in either test, try it again and determine how far beyond the 3% and 5% grade marks you must go before the indicator moves. Check the thread to see that it is free from snags.
10. If the indicator moves when the block is placed 1" beyond the 3% and 5% grade marks, you can consider your testing correct. The friction, measurements, and materials account for the difference in this test.
11. Were your grade limit figures correct? (Yes/No)

______________________

## Clean Up

12. Disassemble the apparatus and return all equipment and supplies to their proper places.

**ACTIVITY 14C**

# Analyzing the Design

Today you will prepare and present to the class a report about the bridge counterbalance weight test and the roadway grade limit test you performed in Activity 14A and B.

**Problem**

### Objective:

Given the test results from Activity 14A and B, prepare and present to the class a report of the findings from testing a model bridge counterbalance weight and a model roadway grade limit.

### Preparing Your Project

1. As members of an engineering team, three members should prepare a report on the bridge and two members prepare a report on the roadway. You have 10 minutes in which to prepare your reports.
2. Identify the bridge span or roadway grade for which you were responsible.
3. Indicate whether your bridge span or roadway grade limit worked or did not work. If it did not work, why not?
4. Explain how you figured your counterbalance weight for the bridge or the grade limit for the roadway.
5. Select one structural engineer and one civil engineer from your group to present your report.

### Giving the Report

6. Your group has 5 minutes in which to present your report to the rest of the class.

### Outline Your Report

**ACTIVITY 15**

# Selecting the Design

Acting as a design selection committee, your committee will choose the most appropriate design for a bascule bridge or a roadway for the community park. You will then present your choice to the class.

Fig. 15-1. Bascule Bridge Design Requirements

**Site Conditions**

1. The river's width is 30′.
2. The river's depth is 15′.
3. The water level is 5′ below grade
4. See view A.

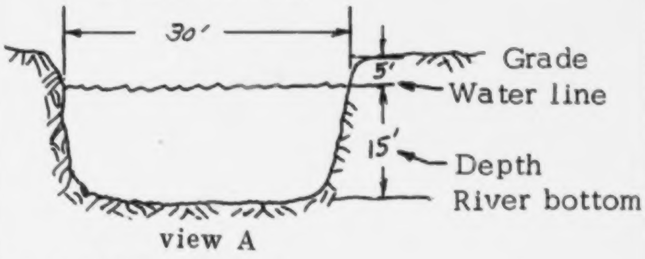


Fig. 15-1A. Bridge Site

**Site Location**

1. Bridge is located on entrance road between highway and parking area. See Fig. 15-2.

**Contract Conditions**

1. Bridge must be constructed in 6 months.
2. Total cost of bridge must not exceed $500,000.

**Construction Requirements**

1. Bridge must be made with at least 3 I-beam girders with steel webbing every 4′. See Fig. 15-4.
2. Roadway must be 4″ concrete with steel mesh reinforcement. See Fig. 15-4.
3. Roadway must have at least 2″ blacktop. See Fig. 15-4.

**Problem 1**

### Objective:

Given the design requirements and construction specifications for a bascule bridge:

a. Act as a design selection committee.
b. Select the best bascule bridge design for the community park and present the selection to the class.

### Selecting the Design

1. Your group will select the best bascule bridge design for the community park.
2. Study Fig. 15-1, Bascule Bridge Design Requirements. Also study Fig. 15-2 and Fig. 15-4.
3. From Fig. 15-3, Bascule Bridge Construction Specifications, choose a bridge which you believe meets the design requirements. Check Fig. 15-5, Span and Pier Distances, before making your final choice.

### Preparing Your Presentation

4. Prepare your presentation by answering the following questions:

a. Which bascule bridge design did you select?

Number ____

b. What is the distance between piers? (From Fig. 15-5.)

____________________

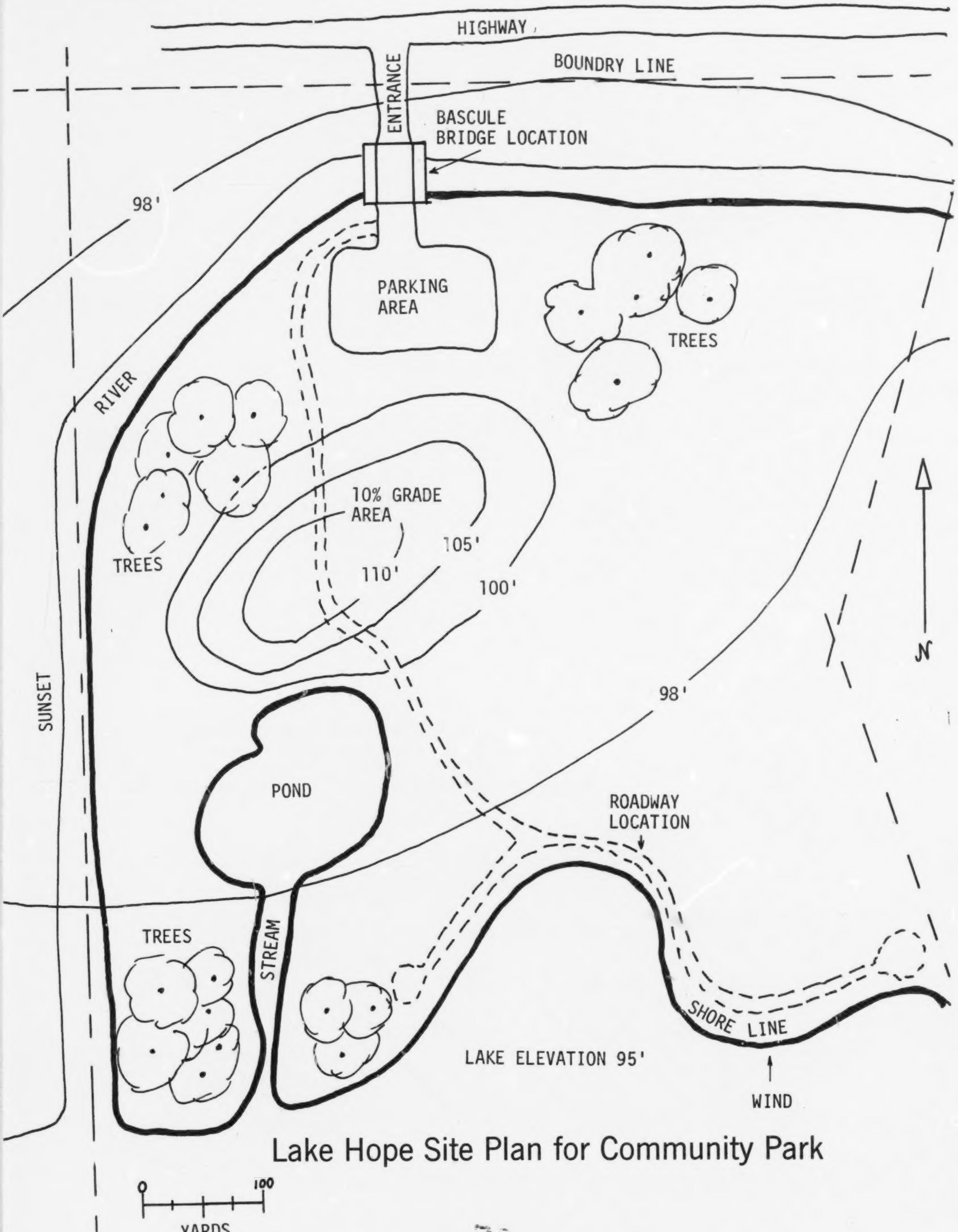
c. What is the total construction cost? (From Fig. 15-3.)

____________________

d. Why did the committee select this bridge design? (Check)

____ cost, ____ design

____ material, ____ construction


HIGHWAY
BOUNDRY LINE
ENTRANCE
BASCULE
BRIDGE LOCATION
98'
PARKING
AREA
TREES
RIVER
TREES
10% GRADE
AREA
105'
110'
100'
TREES
SUNSET
98'
N
POND
ROADWAY
LOCATION
TREES
STREAM
SHORE LINE
LAKE ELEVATION 95'
WIND
0
100
YARDS

Lake Hope Site Plan for Community Park

Fig. 15-2

Fig. 15-3. Bascule Bridge Construction Specifications

| Bridge Type | Total Length (both spans) | Roadway Span Support Material | Construction Time | Roadway Material | Total Construction Cost |
|---|---|---|---|---|---|
| 1 | 16′ | 2 I-beam girders<br>4 steel webs | 3 months | 4″ Concrete with steel mesh reinforcement | $ 50,000 |
| 2 | 24′ | 2 I-beam girders<br>6 steel webs | 4 months | 4″ Concrete with steel mesh reinforcement<br>2″ Blacktop | $100,000 |
| 3 | 24′ | 3 I-beam girders<br>6 steel webs | 5 months | 4″ Concrete with steel mesh reinforcement<br>2″ Blacktop | $200,000 |
| 4 | 48′ | 3 I-beam girders<br>12 steel webs | 6 months | 4″ Concrete with steel mesh reinforcement<br>2″ Black top | $250,000 |
| 5 | 48′ | 3 I-beam girders<br>12 steel webs | 6 months | 4″ Concrete with steel mesh reinforcement<br>3″ Blacktop | $300,000 |

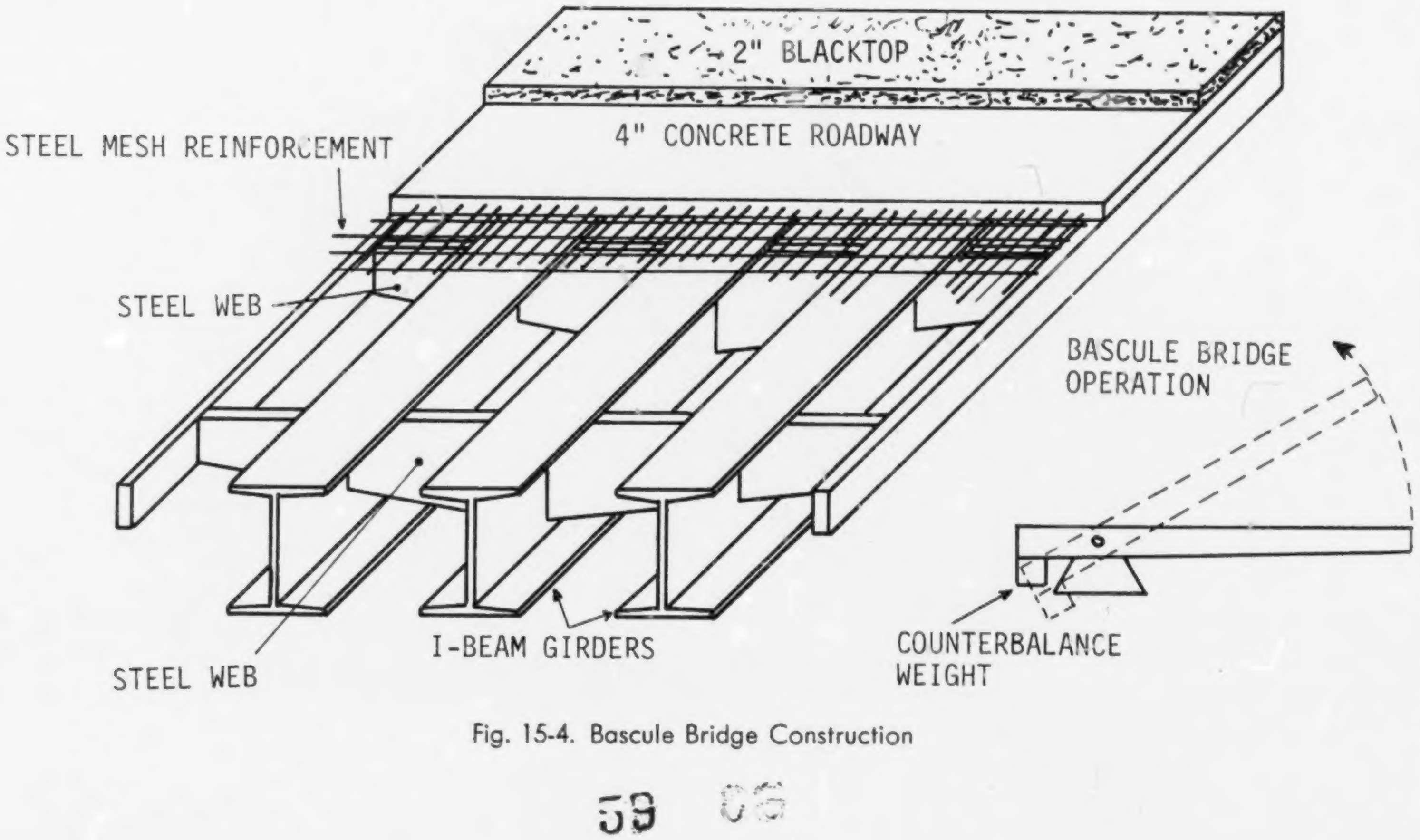

2" BLACKTOP
4" CONCRETE ROADWAY
STEEL MESH REINFORCEMENT
STEEL WEB
BASCULE BRIDGE OPERATION
I-BEAM GIRDERS
STEEL WEB
COUNTERBALANCE WEIGHT

Fig. 15-4. Bascule Bridge Construction

Fig. 15-5. Span and Pier Distances

| Bascule Bridge Type | T Total Length (both spans) | A Length of One Span | B Length of Shorter Arm | C Length of Longer Arm | X Distance Between Piers |
|---|---|---|---|---|---|
| 1 | 16′ | 8′ | 2′ | 6′ | 8′ |
| 2 | 24′ | 12′ | 3′ | 9′ | 14′ |
| 3 | 24′ | 12′ | 4′ | 8′ | 12′ |
| 4 | 48′ | 24′ | 6′ | 18′ | 32′ |
| 5 | 48′ | 24′ | 8′ | 16′ | 30′ |

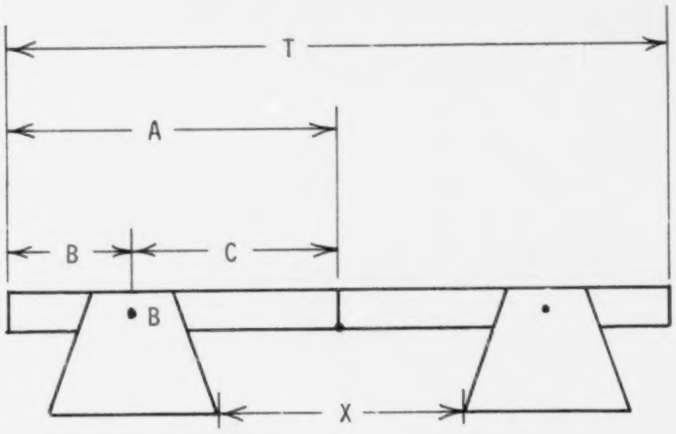


Fig. 15-6. Roadway Design Requirements

**Site Conditions**

1. The earth's surface at one point has a 10% grade. See Fig. 15-2.
2. The soil is a mixture of gravel and sand.

**Site Location**

1. The roadway is to be located between the parking lot and the boat dock. See Fig. 15-2.
2. The roadway must go over the 10% grade to leave flat land for playing fields.

**Contract Conditions**

1. The roadway must be constructed in 3 months.
2. Total cost of the roadway must not exceed $75,000.

**Construction Conditions**

1. The roadway must not exceed 4% grade.
2. It is to be constructed so that maintenance cost does not exceed $3,000 per year.

## Presenting Selection to Class

5. Select one member of the committee to present the group's selection to the class.

**Problem 2**

## Objective:

Given the design requirements and construction specifications for a roadway:

a. Act as a design selection committee.
b. Select the best roadway design for the community park and present the selection to the class.

## Selecting the Design

1. Your group will select the best roadway design for the community park.
2. Study Fig. 15-6, Roadway Design Requirements. Also study Fig. 15-2.
3. From Fig. 15-7, Roadway Construction Specifications, choose a roadway which you believe meets the design requirements.

Fig. 15-7. Roadway Construction Specifications

| Roadway | Surface Material | Construction Time | Maximum Grade | Total Construction Cost | Maintenance Cost Per Year |
|---|---|---|---|---|---|
| 1 | Concrete or blacktop | 3 months | 4.3% | $70,000 | $1,000 |
| 2 | Gravel | 2 months | 4.2% | $60,000 | $2,000 |
| 3 | Sand | 2 months | 4.0% | $50,000 | $3,000 |

## Preparing Your Presentation

4. Prepare your presentation by answering the following questions.
   a. Which roadway design did you select?

      Number ____

   b. What is the total construction cost? (From Fig. 15-7.)

      ____________________

   c. What is the maintenance cost per year? (From Fig. 15-7.)

      ____________________

   d. Why did the committee select this roadway design? (check)

      ____ construction cost
      ____ maintenance cost
      ____ material used
      ____ grade limit
      ____ construction time

## Presenting Selection to Class

5. Select one member of the committee to present the group's selection to the class.

**ACTIVITY 16A**

# Making Working Drawings

## Problem

### Objective:

Using a set of contract working drawings, you are to read the drawings and identify:

a. Location of the house.
b. The overall length and width of the house and garage.
c. The scale of the left, right, and rear elevations.
d. The depth of the concrete block foundation wall.
e. The roof detail, and heating plans.

**Supplies** (Group of 5)

1 set working drawings (8 sheets, All American Homes, Inc.)

### Reading Working Drawings

1. On Sheet 1, find Lot No. 262 and the direction arrow. Where is this lot located in relation to the other lots? (Check which apply.)
    West of Lot 261 ____
    East of Lot 261 ____
    North side of Carrousel Drive ____
    South side of Carrousel Drive ____
    Front of house is 26′ from sidewalk ____
    Front of house is 40′ from sidewalk ____
2. On Sheet 2, what are the overall dimensions of the house?
    length ____ width ____
    What are the overall dimensions of the basement area?
    length ____ width ____
3. According to the 1st floor plan, Sheet 3, how many bedrooms does this house have?
    ____________
    How big is bedroom 2?
    length ____ width ____
    What are the exterior dimensions of the garage?
    length ____ width ____
4. On Sheet 4, what are the scales of the left, right, and rear elevations?
    left______ right______ rear______
5. On Sheet 5 showing all sections, how many concrete blocks deep is the basement under the house?
    ____________
6. What two drawings are found on Sheet 6?
    ____________ and ____________
7. Sheets 7 and 8 are *not* commonly included in a simple set of working drawings. What information do they provide?
    (Check your answers.)
    ____ Electrical
    ____ Plumbing
    ____ Heating
    ____ Structural details
    How many registers are in the living room?
    ____________
8. How many steps are there from the 1st floor to the basement floor?
    ____________
9. Does this house have a fireplace?
    ____________
10. What is the difference between the Bath and Lav.?
    ____________
    ____________

**ACTIVITY 16B**

# Making Working Drawings

Today you will complete a site plan with dimensions.

**Problem**

## Objective:

Using the contour map of a building site:

a. Locate, lay out, and sketch a structure to scale.
b. Locate a driveway.
c. Record dimensions.

**Equipment** (Each student)

| | |
|---|---|
| 1 | 12″ rule |
| 1 | 1½″ x 2½″ paper house (precut) |
| 1 | 1¼″ x 1¼″ paper garage (precut) |

## Requirements for Locating the Structures

1. Use the following information to help you complete the drawing correctly. See Fig. 16B-1.
   a. State Avenue runs north and south.
   b. Corners of the property line are marked to show elevations in feet above sea level.
   c. The finished floor level of the house is to be 523′.
   d. The overall size of the house is to be 30′ x 50′.
   e. The two-car garage will be 25′ x 25′, *unattached.*
   f. Buildings are to be placed no closer than 10′ from property lines (local building code).
   g. The driveway entrance may be from State Avenue *or* Main Street.
   h. The driveway is to be 10′ wide at the street, widening to 20′ for a parking area near the garage door.
   i. This contour map is drawn to the scale 1″ = 20′.

## Locating the Structures

2. Lay out setback lines 10′ (½″) from the property lines.
3. Place the house cutout and garage cutout on the site. Move them around until you think you have a good location. Remember that the finished floor level is to be at the 523′ elevation.
4. Provide in your solution for the placement of the driveway. Take contour lines into consideration. Make the driveway as level as possible, no steep climbs or major earth excavations are permitted for the driveway.

## Drawing

5. Check the location of the house and garage with your teacher. Then trace around them.

## Recording Dimensions

6. Record the following dimensions in feet. (Remember 1″ = 20′.)

Distance from house and garage to:

a. West property line ____′

b. East property line ____′

c. North property line ____′

d. South property line ____′

Distance from garage to:

a. West property line ____′

b. East property line ____′

c. North property line ____′

d. South property line ____′

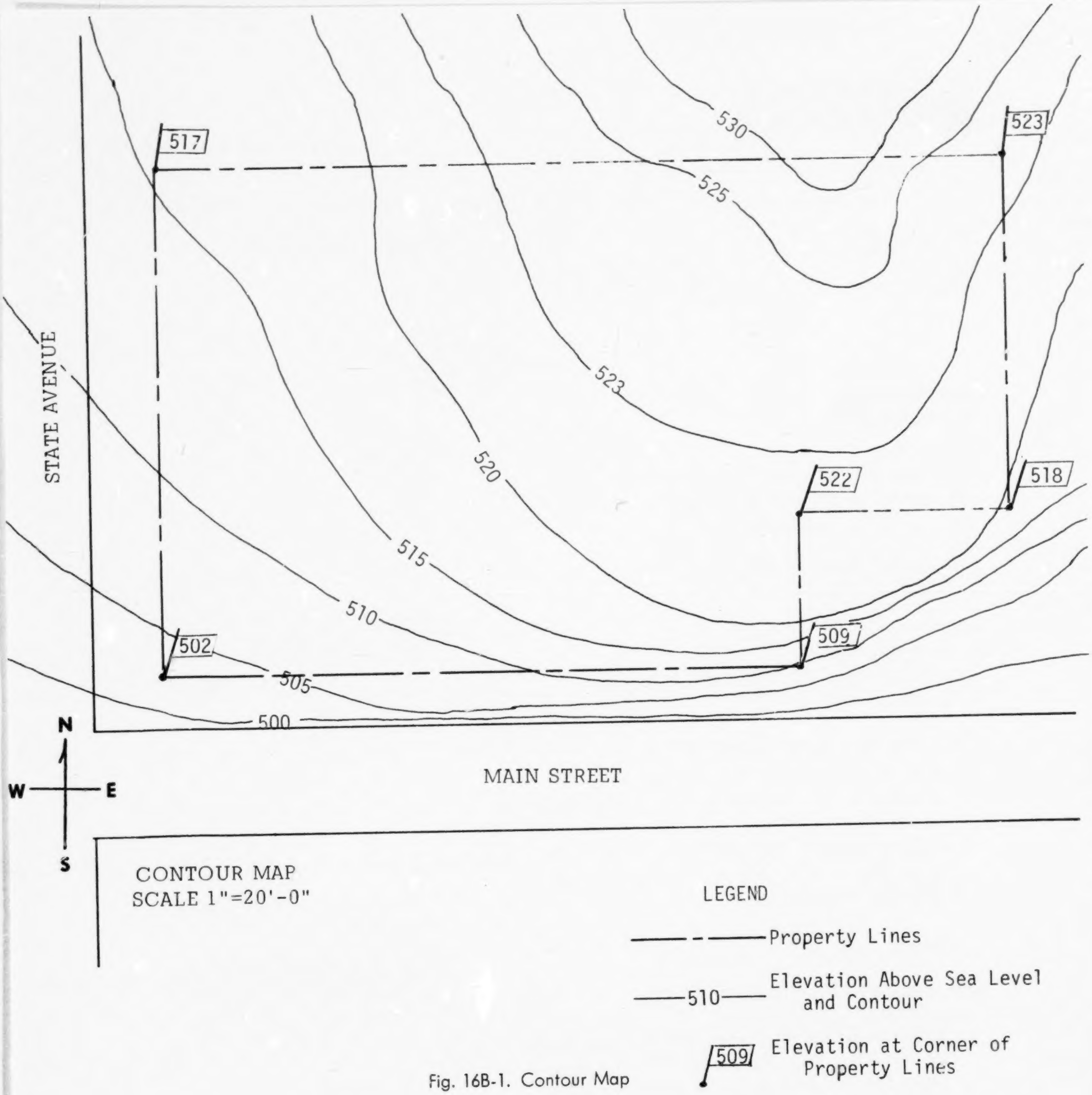

517
523
530
525
523
520
515
510
505
500
522
518
509
502
STATE AVENUE
MAIN STREET
N
W
E
S
CONTOUR MAP
SCALE 1"=20'-0"
LEGEND
Property Lines
510
Elevation Above Sea Level and Contour
509
Elevation at Corner of Property Lines

Fig. 16B-1. Contour Map

7. Record the following dimensions.
   Distance from:
   a. Corner stake 502 to corner stake 517

   ______'

   b. Corner stake 517 to corner stake 523

   ______'

   c. Corner stake 523 to corner stake 518

   ______'

   d. Corner stake 518 to corner stake 522

   ______'

## Checking

8. Double check your dimensions and layout for accuracy.

**ACTIVITY 16C**

# Making Working Drawings

## Problem

### Objective:

Given the design requirements of a garage, draw a foundation plan to scale and dimension the drawing.

**Equipment** (Each student)
1 12″ rule

**Supplies** (Each student)
1 pencil/eraser
1 sht. 8½″ x 11″ tracing paper
2 paper clips

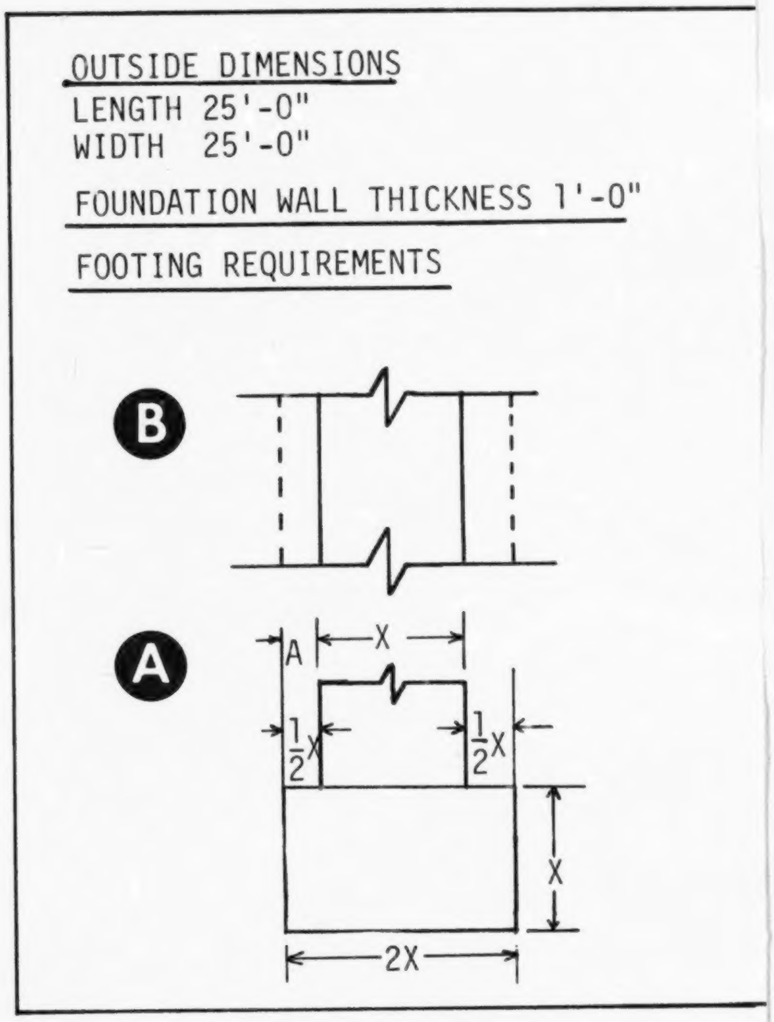
### Reading the Design Requirements

1. Fig. 16C-1 shows the design requirements for the foundation of a garage. Study Fig. 16C-1 and view A.
2. Substitute the 1′ 0″ (12″) for X in view A of Fig. 16C-1 and figure the dimension for the distance A.

A = ____″

### Drawing the Foundation Plan

3. Paper clip the tracing paper to the Grid Sheet (Fig. 16C-2) at the top corners.
4. Fig. 16C-2 Grid Sheet is marked with lines ¼″ apart. The scale of the grid is ¼″ = 1′. Starting at the "└" count off the length of the garage and make a mark "┌". Count off the width of the garage and make a mark "┘". Locate the last corner of the garage.
5. Draw the outside line of the garage.
6. Draw the inside line of the garage. It is the inside of the foundation wall shown in Fig. 16C-1.
7. Locate the inside and outside edges of the footing.



OUTSIDE DIMENSIONS
LENGTH 25'-0"
WIDTH 25'-0"

FOUNDATION WALL THICKNESS 1'-0"

FOOTING REQUIREMENTS

Fig. 16C-1. Design Requirements of Garage Foundation

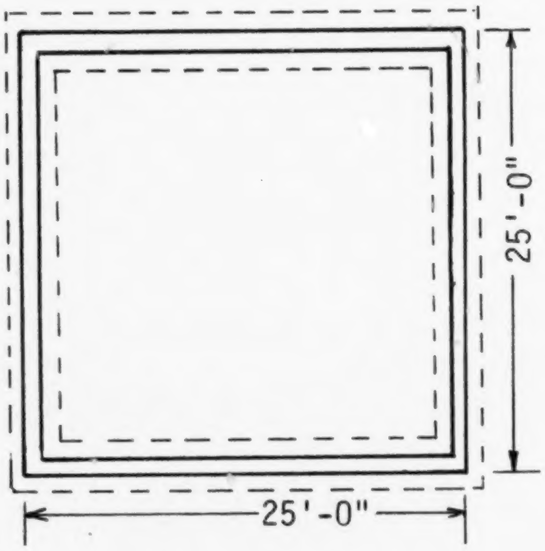
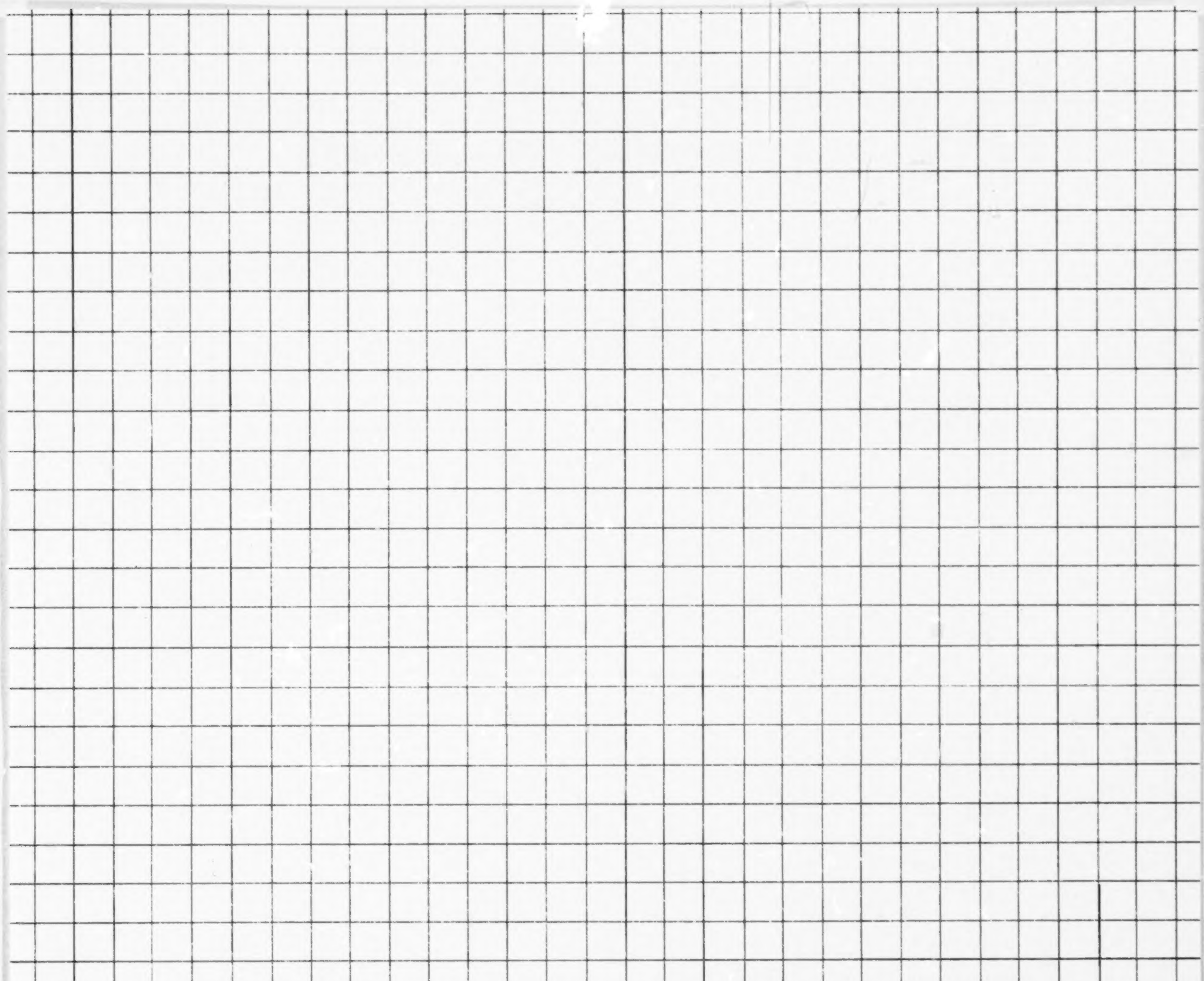


Fig. 16C-3. Dimensions of Garage


LENGTH
WIDTH

SCALE: ¼" = 1'

Fig. 16C-2. Grid Sheet

8. Draw the footing lines as short dashes. See view B in Fig. 16C-1.

## Dimensioning the Drawing

9. Draw and dimension the length of the garage on the right side of the plan. See Fig. 16C-3.
10. Draw and dimension the width of the garage at the bottom of the plan. See Fig. 16C-3.

## Titling the Drawing

11. In the lower right hand corner of the drawing, print:

    GARAGE FOUNDATION
    Scale: 1/4″ = 1′ 0″

    Drawn By (Your name)
12. Show your drawing to the teacher for approval. Hand in your foundation plan when the teacher calls for it.

**ACTIVITY 16D**

# Making Working Drawings

**Problem**

## Objective:

Given the design requirements and the appropriate symbols make a section drawing of a garage foundation to scale.

**Equipment** (Each student)
1 12″ rule

**Supplies** (Each student)
1 sht. 8½″ x 11 tracing paper
2 paper clips

## Reading the Design Requirements

1. Figure 16D-1 shows the specifications, symbols for materials, and scale requirements for the foundation of a garage. Study Fig. 16D-1.
2. Figure 16D-2 shows the section lines A-A from where the section to be drawn will be taken.

## Drawing the Section

3. Paper clip the tracing paper to the Grid Sheet (Fig. 16D-3) at the top corners.
4. Fig. 16D-3 is marked with lines ¼″ apart. The scale of your drawing will be 1″ = 1′ 0″. Thus each square is 3″ and 4 squares = 1′.
5. Starting at "L", draw the footing. It has been started for you. Draw the thickness according to the design requirements. See Fig. 16D-1.
6. Center the wall on the footing, and draw the height and thickness of the wall.
7. Draw the 4″ thick floor even with the top of the 5th block.
8. Draw the grade line even with the top of the 5th block.

## Drawing Symbols

9. Use the appropriate symbols to show the materials used. Follow the design

MATERIALS

FOOTINGS
Concrete footings 12" × 12"
3, ½" reinforced steel rods placed 6" from the bottom and 6" apart.

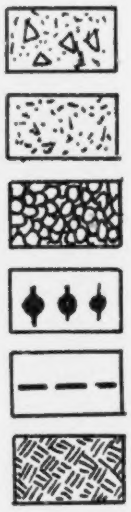
WALL
6 concrete blocks 12" × 12" × 16"

FLOOR
4" concrete slab
6" steel mesh reinforcement placed 2" from bottom of slab.
Floor must be even with the top of the 5th block.

FILL
4" gravel fill under floor slab.
Earth fill under the gravel fill.

GRADE
Earth level with 5th block.

Symbols



Concrete
Concrete block
Gravel fill
Steel rod reinforcement
Steel mesh reinforcement
Earth fill

Scale of Drawing: 1" = 1'-0"

Fig. 16D-1. Design Requirements of the Garage Foundation

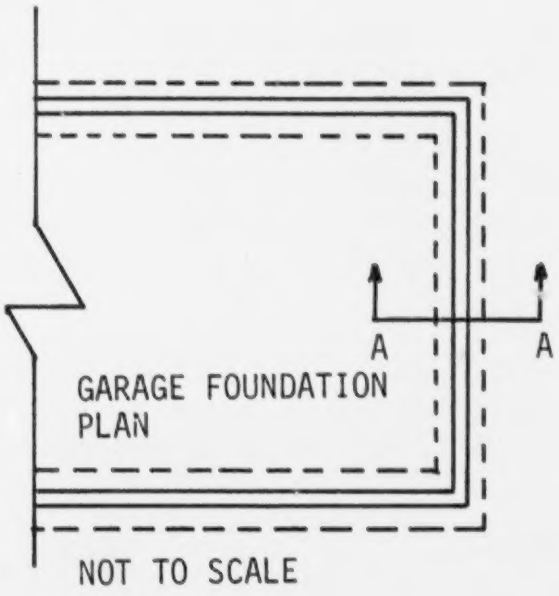


Fig. 16D-2. Foundation Section

requirements for locating the reinforcement steel rod and mesh. See Fig. 16D-1.

## Adding Notes

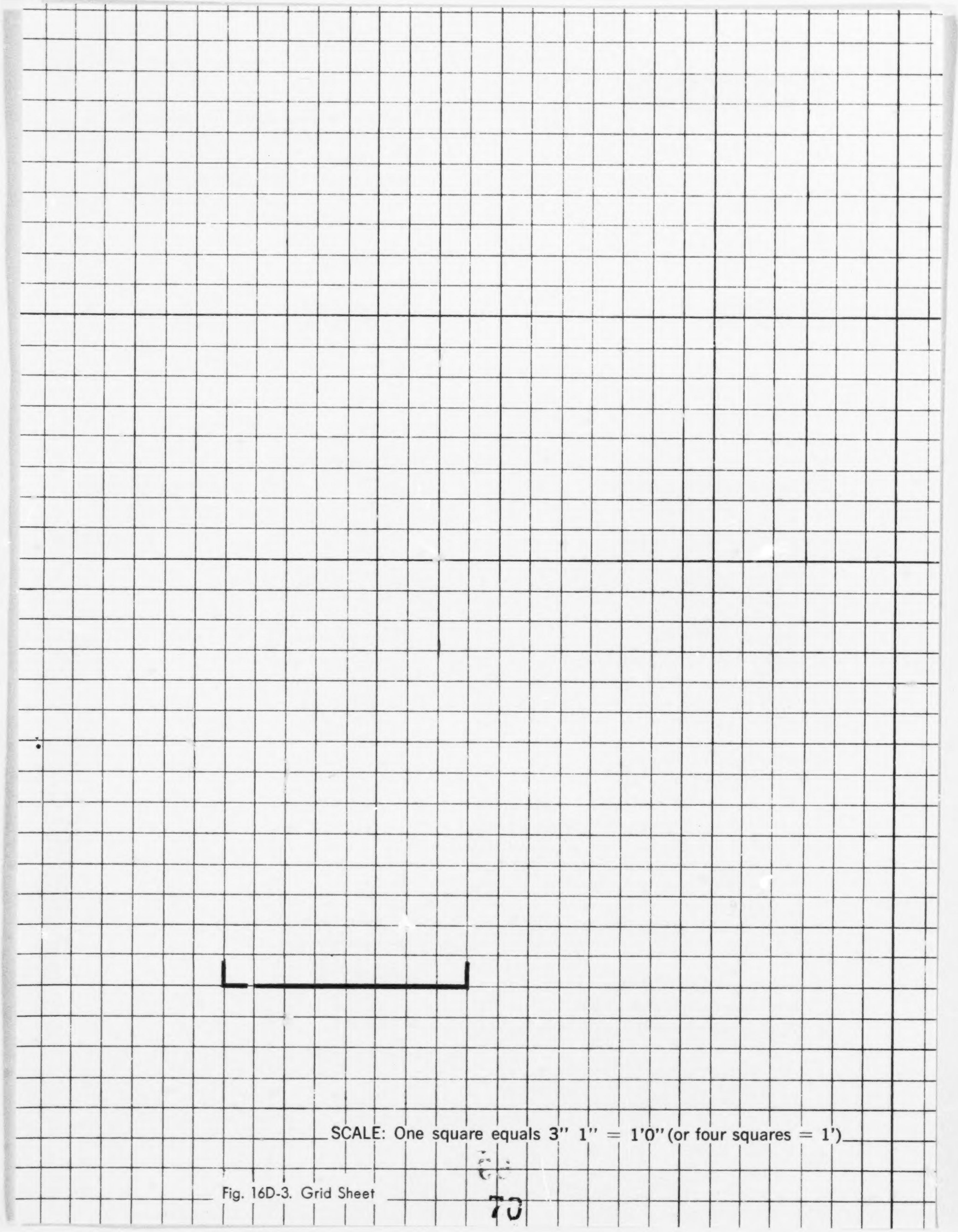
10. Beside each material print the name of the material according to the design requirements in Fig. 16D-1.

## Titling the Drawing

11. In the lower right hand corner of the drawing, print:

    GARAGE FOUNDATION
    SECTION A-A
    Scale: 1″ = 1′

    Drawn by (Your name)
12. Show your drawing to the teacher for approval. Hand in your section drawings when the teacher calls for them.



SCALE: One square equals 3" 1" = 1'0" (or four squares = 1')

Fig. 16D-3. Grid Sheet

**ACTIVITY 16E**

# Making Working Drawings

## Problem

### Objective:

Given the floor plan for a proposed room and porch addition and the needed equipment and supplies, draw a foundation plan showing the foundation wall and foundation footing.

**Equipment** (Each student)

1 12″ rule with 16th's

**Supplies** (Each student)

1 sht. 8½″ x 11″ tracing paper
1 pencil/eraser
2 paper clips

### Preparing to Work

1. Fasten a piece of tracing paper over the floor plan (Fig. 16E-1) with paper clips. Trace the frame wall of the family room addition and the porch. Study Fig. 16E-1.

### Measuring and Drawing the Foundation Wall

2. Measure out the distances representing the 8″ wide foundation walls. Use the inside of the frame wall as the center line of the foundation wall. (Measure 3/16″ in both directions from the line. See Fig. 16E-2.
3. Draw the foundation walls for the room and porch.

### Measuring and Drawing the Foundation Footings

4. Measure out the distances representing the 16″ wide footing. It should be 3/16″ each side of the foundation wall. See Fig. 16E-2.
5. Draw dashed lines to show the foundation footing in the manner that your teacher has shown you.

### Dimensioning

6. Dimension the foundation plan according to your teacher's directions.
7. Print your name on drawing.
8. Have your teacher approve your drawing.

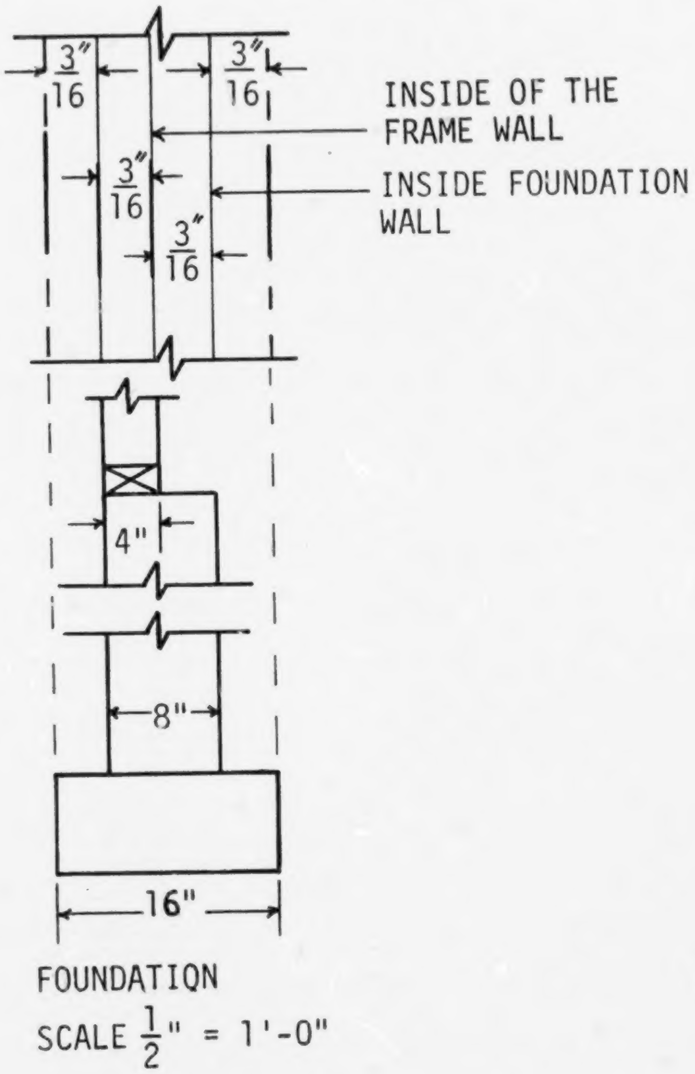


Fig. 16E-2. Foundation Wall

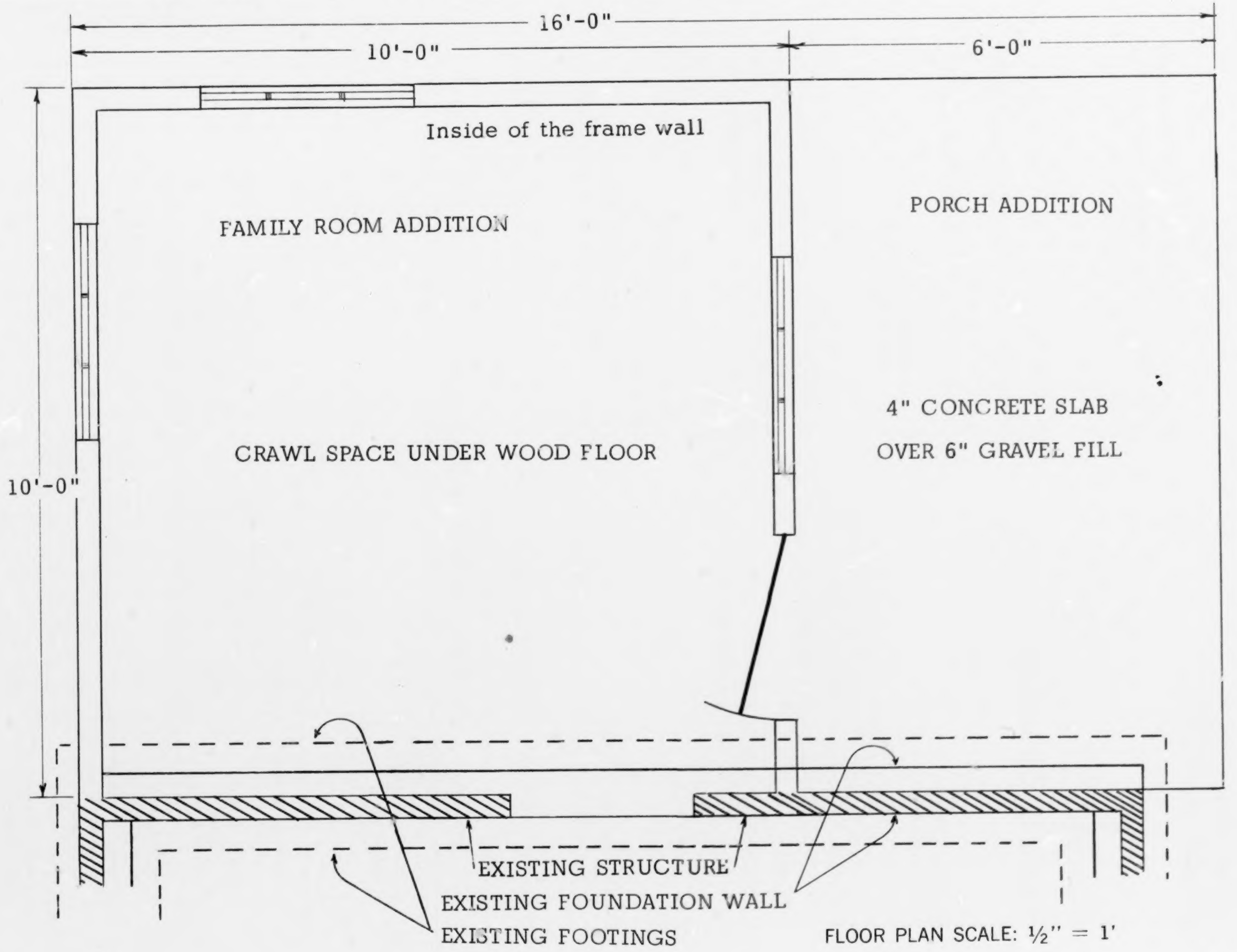

16'-0"
10'-0"
6'-0"
Inside of the frame wall
FAMILY ROOM ADDITION
PORCH ADDITION
4" CONCRETE SLAB
OVER 6" GRAVEL FILL
CRAWL SPACE UNDER WOOD FLOOR
10'-0"
EXISTING STRUCTURE
EXISTING FOUNDATION WALL
EXISTING FOOTINGS
FLOOR PLAN SCALE: ½" = 1'

Fig. 16E-1. Proposed Room Addition

**ACTIVITY 16F**

# Making Working Drawings

**Problem**

## Objective:

Given the floor plan for a house and an Electrical Legend and Fixture Schedule, locate the position of electrical fixtures on a floor plan.

**Supplies** (Each student)

| | |
|---|---|
| 1 | 8½″ x 11″ tracing paper sheet |
| 1 | pencil/eraser |
| 2 | paper clips |
| 1 | 12″ rule |

## Preparing to Work

1. Study the Electrical Legend and Fixture Schedule (Fig. 16F-1) and Floor Plan (Fig. 16F-2). The fixtures are the minimum number required. You can have more.

## Sketching Symbols

2. Paper clip the sheet of tracing paper over the floor plan.
3. Decide where you would place the following fixtures:
   a. Entrance meter
   b. Distribution panel
   c. Convenience outlets
   d. Ceiling-mounted light fixture
   e. Wall switches
4. Locate and draw the correct symbols on the floor plan in the places you have selected. Do not make your symbols too large.
5. Draw a broken line (long dash - short dash) from each switch to the light or lights it controls.
6. Print your name on the drawing.
7. Have the teacher approve your electrical plan.

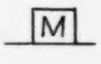
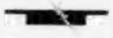
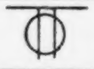
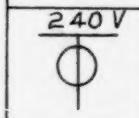
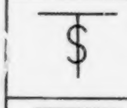
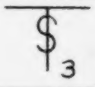
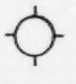
| | | | NUMBER REQUIRED | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Symbol | Description | Voltage | Bedroom 1 | Bedroom 2 | Bedroom 3 | Bath | Util. & Kitchen | Dining & Living Room | Hall |
|  | Entrance meter and 150 Amp disconnect switch | 120V<br>240V | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
|  | Distribution panel | 120V<br>240V | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
|  | Convenience outlet | 120V | 4 | 4 | 4 | 1 | 4 | 5 | 1 |
|  | Special purpose, 240V outlet for large appliance | 240V | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
|  | Single pole toggle switch | 120V | 1 | 1 | 1 | 1 | 2 | 2 | 0 |
|  | Three way toggle switch | 120V | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
|  | Ceiling mounted light fixture | 120V | 1 | 1 | 1 | 1 | 2 | 2 | 1 |

Fig. 16F-1. Electrical Legend and Fixture Schedule

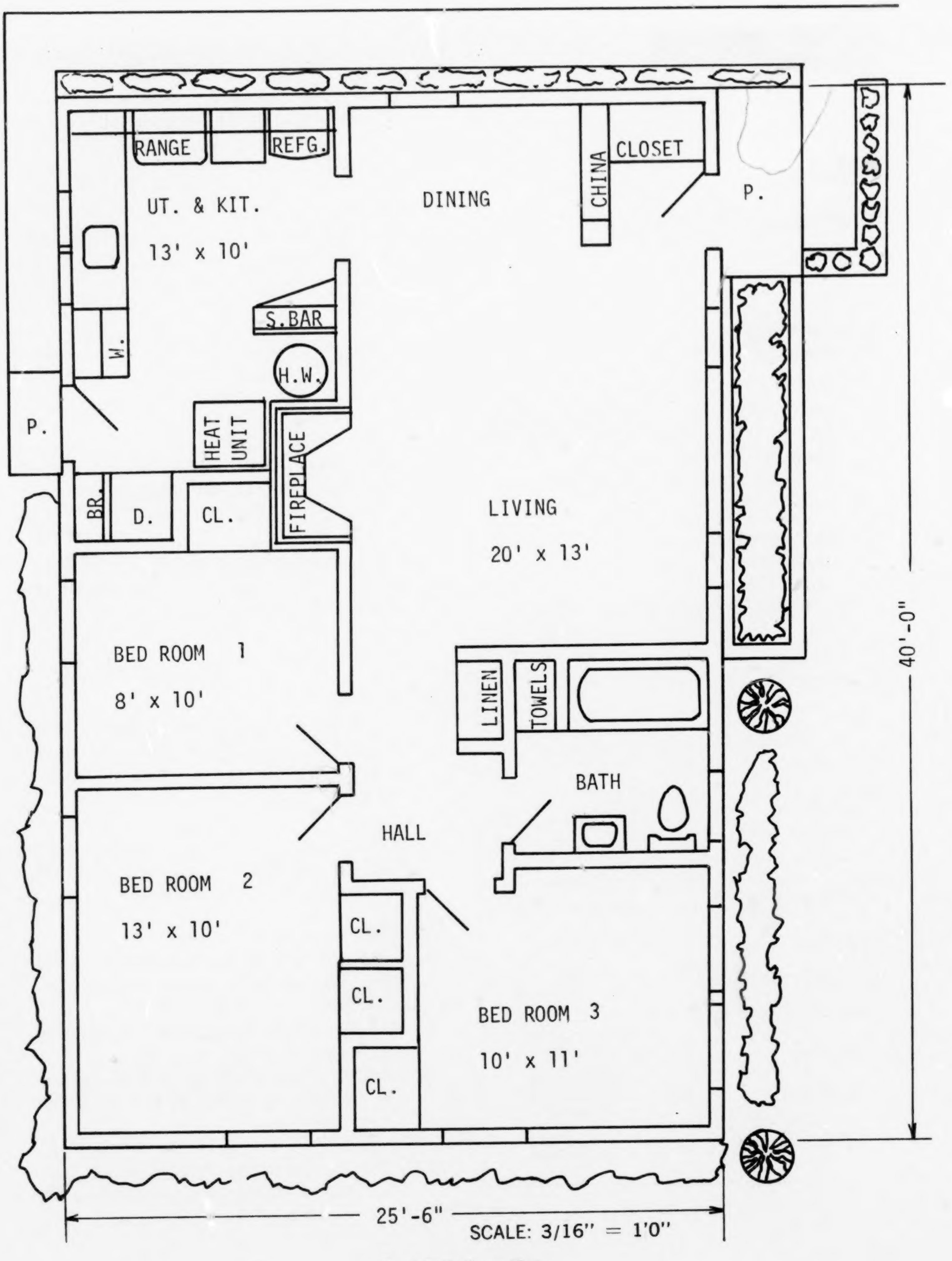

RANGE
REFG.
UT. & KIT.
13' x 10'
DINING
CHINA
CLOSET
P.
S.BAR
W.
H.W.
P.
HEAT UNIT
FIREPLACE
BR.
D.
CL.
LIVING
20' x 13'
BED ROOM 1
8' x 10'
LINEN
TOWELS
BATH
HALL
BED ROOM 2
13' x 10'
CL.
CL.
CL.
BED ROOM 3
10' x 11'
40'-0"
25'-6"
SCALE: 3/16" = 1'0"

Fig. 16F-2. Floor Plan

**ACTIVITY 16G**

# Making Working Drawings

## Problem

### Objective:

Given a set of stairway design factors:

a. Figure the number of concrete stair risers and treads needed for a given rise, and the width of a tread.

b. Draw the stairs.

**Supplies** (Each student)

1 pencil/eraser
2 paper clips
1 sht. 8½" x 11" tracing paper

DIMENSIONS

Run - 5' 3"
Rise - 4' 0"
6" risers

MATERIALS

Concrete steps
Concrete risers
2, ½" reinforcement steel rods per step
6" steel reinforcement mesh in stringer

SYMBOLS

| | |
|---|---|
| Reinforcement rod | ⧫ |
| Reinforcement mesh | - - - - - |
| Concrete | ▨ |
| Earth fill | ▩ |
| Stone fill | ▦ |

Fig. 16G-1. Stairway Design Requirements

### Preparing to Work

1. Figure 16G-1 gives design requirements for the stairway. Study these requirements.

### Figuring

2. The number of 6" risers can be found by the following formula:

$$\frac{\text{total rise}}{\text{rise/step}} \quad \frac{4'0''}{6''} = \frac{48''}{6''} = \_\_\_\_ \text{ risers}$$

3. There is always one less tread than there are risers. Therefore, subtract one from the number of risers.

$\_\_\_\_ - 1 = \_\_\_\_$

4. The width of the treads can be found by using the following formula:

$$\frac{\text{run}}{\text{no. of treads}} \quad \frac{5'3''}{7} = \frac{63''}{7} = \_\_\_\_''$$

5. This is the width of one tread in inches. What is the same dimension stated as a fraction of a foot?

________________________

### Measuring

6. Paper clip a piece of tracing paper over Fig. 16G-2. Starting at Point A, mark straight up for the 6" risers. On the drawing 1" = 1'.

6" = ____'

7. Starting at Point B, mark straight across for the tread widths.

### Drawing

8. Using the rule as a straightedge, draw light lines across the page through the rise marks.
9. Now draw light lines down through the run marks.
10. Starting from Point A, darken in the rise and run lines that lead to Point B.

### Using Symbols

11. Draw in the tread reinforcement rod according to the design requirements.
12. Draw in the reinforcement mesh.

13. Using the proper symbols, show that the stairs are concrete.
14. Using the proper symbols, show stone fill or any changes in earth fill.

## Noting

15. Note the reinforcement steel rod as ½″. Note the reinforcement mesh as 6″ sq.
16. Note the run and rise dimensions.
17. Print your name on the drawing.
18. Have your teacher approve your drawing.

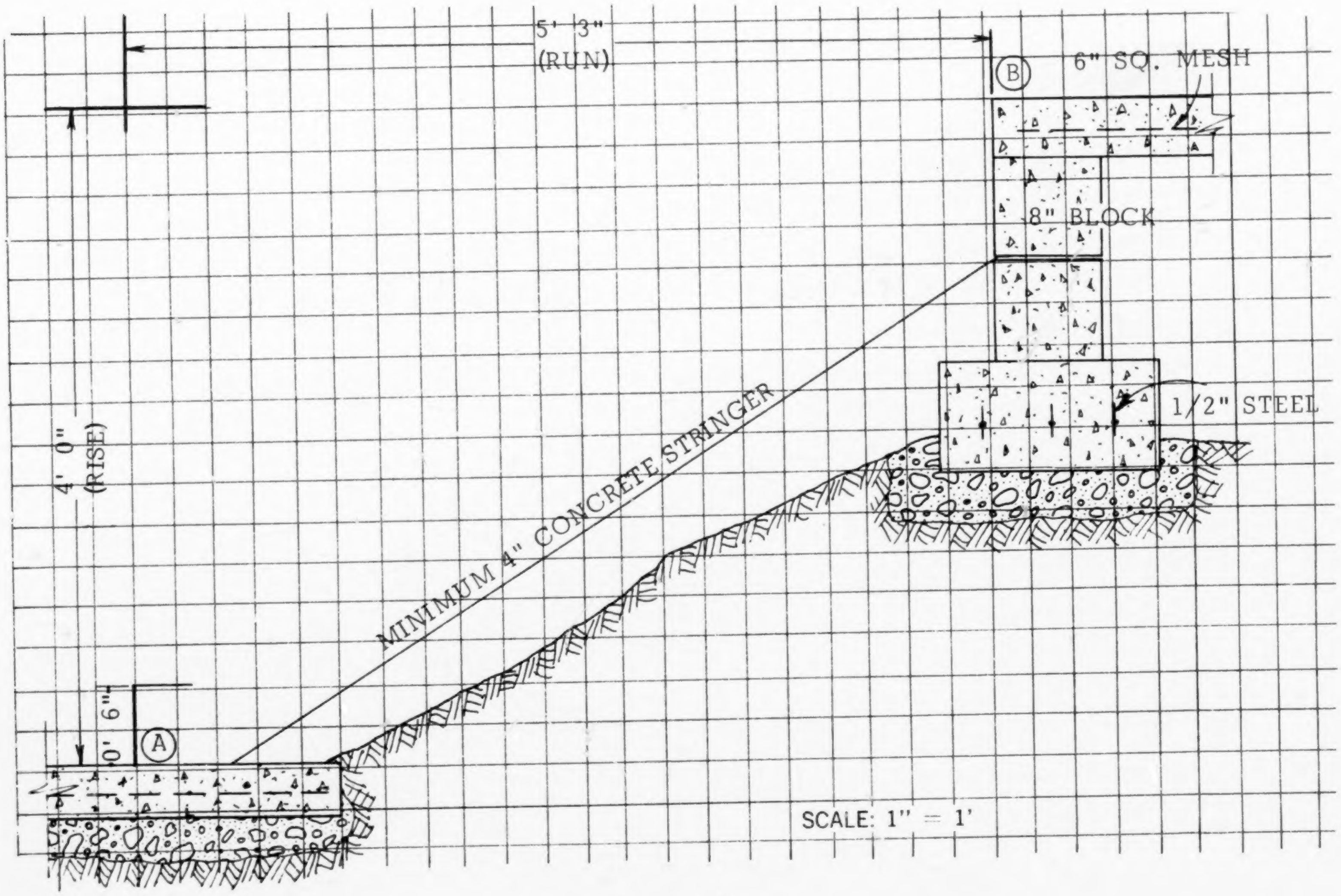

5' 3"
(RUN)
Ⓑ
6" SQ. MESH
8" BLOCK
1/2" STEEL
4' 0"
(RISE)
MINIMUM 4" CONCRETE STRINGER
0' 6"
Ⓐ
SCALE: 1" = 1'

Fig. 16G-2. Stair Detail

## ACTIVITY 17A

# Writing Specifications

### Problem

### Objective:

Given a builders' supply catalog, complete a plumbing fixture specifications sheet.

**Supplies** (Group of 5)

1 builders' supply catalog

### Preparing to Work

1. Get one of the builders' supply catalogs. The foreman will assign one room from Fig. 17A-1 to each member of your group. You will have to take turns using the catalog.
2. In the catalog, locate the plumbing fixtures from the index.

### Recording

3. Fill in the catalog number, description, and cost for each listed fixture on the Plumbing Fixtures Specifications Sheet (Table 17A-1).
4. Total the cost of the plumbing fixtures.
5. If your cost is more than the allotted maximum cost of $500, you must substitute a less costly item.
6. When you have finished work on your assigned plumbing fixtures, hand the catalog to the next group member.

Fig. 17A-1. Plumbing Fixtures Specifications Sheet (Allotted maximum cost: $500)

Listed by______________________________
Name

| Room | Fixture | Catalog Number | Description | Cost |
|---|---|---|---|---|
| Kitchen | sink | | | |
| | faucet | | | |
| | drain | | | |
| | accessories | | | |
| | | | | |
| | disposal | | | |
| | | | Total | |
| *Bath next to* Bedroom 1 | | | | |
| | sink | | | |
| | faucet | | | |
| | toilet | | | |
| | accessories | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | Total | |
| Hall Bath | | | | |
| | tub | | | |
| | faucet | | | |
| | shower acc. | | | |
| | toilet | | | |
| | sink | | | |
| | faucet | | | |
| | accessories | | | |
| | | | | |
| | | | | |
| | | | Total | |

**ACTIVITY 17B**

# Writing Specifications

**Problem**

## Objective:

Using a door specification sheet, complete the door specifications by recording catalog number, description, and cost for each door.

**Supplies** (Group of 5)
1 builders' supply catalog

### Preparing to Work

1. Read the Door Specification Sheet (Fig. 17B-1). The foreman will assign one group of doors to everyone in the group.
2. Your group will share a builders' supply catalog.
3. In the catalog, locate the door listings from the index.

### Recording

4. For each door in your group, fill in the catalog number, description, and cost on the door specifications sheet.
5. Total the cost of doors.
6. If your cost is over the allotted maximum cost of $400, you must substitute a less costly item.
7. When you are finished with your assigned doors, hand the catalog to your next group member.

Fig. 17B-1. Door Specification Sheet
(Allotted maximum cost: $400 for each group of doors)

| Location | Door Size | Quantity | Mat'l | Type | Catalog No. | Description | Cost |
|---|---|---|---|---|---|---|---|
| Exterior Doors | 2′ 8″ x 6′ 8″ | 2 | wood | hinged | | | |
| | 6′ 0″ x 6′ 8″ | 1 | wood | sliding | | | |
| | 3′ 0″ x 6′ 8″ | 1 | wood | hinged | | | |
| | | | | | | | |
| Interior Doors | 2′ 6″ x 6′ 8″ | 4 | wood | hinged | | | |
| | 2′ 0″ x 6′ 8″ | 1 | wood | hinged | | | |
| | 2′ 4″ x 6′ 8″ | 1 | wood | hinged | | | |
| | | | | | | | |
| Interior Closet Doors | 1′ 6″ x 6′ 8″ | 1 | wood | hinged | | | |
| | 2′ 0″ x 6′ 8″ | 1 | wood | hinged | | | |
| | 3′ 0″ x 6′ 8″ | 2 | wood | hinged | | | |
| | 2′ 6″ x 6′ 8″ | 3 | wood | sliding | | | |
| | | | | | | Total | |

**ACTIVITY 18**

# The Designing and Engineering Cycle

## Problem

### Objective:

Given a new set of requirements, redesign a park site.

**Supplies** (Each student)

1 Site Plan of Community Park
(from Activity 13A)
1 sht. 8½″ x 11″ tracing paper
2 paper clips

**Equipment** (Each student)

1 12″ rule

### Identifying the Problem

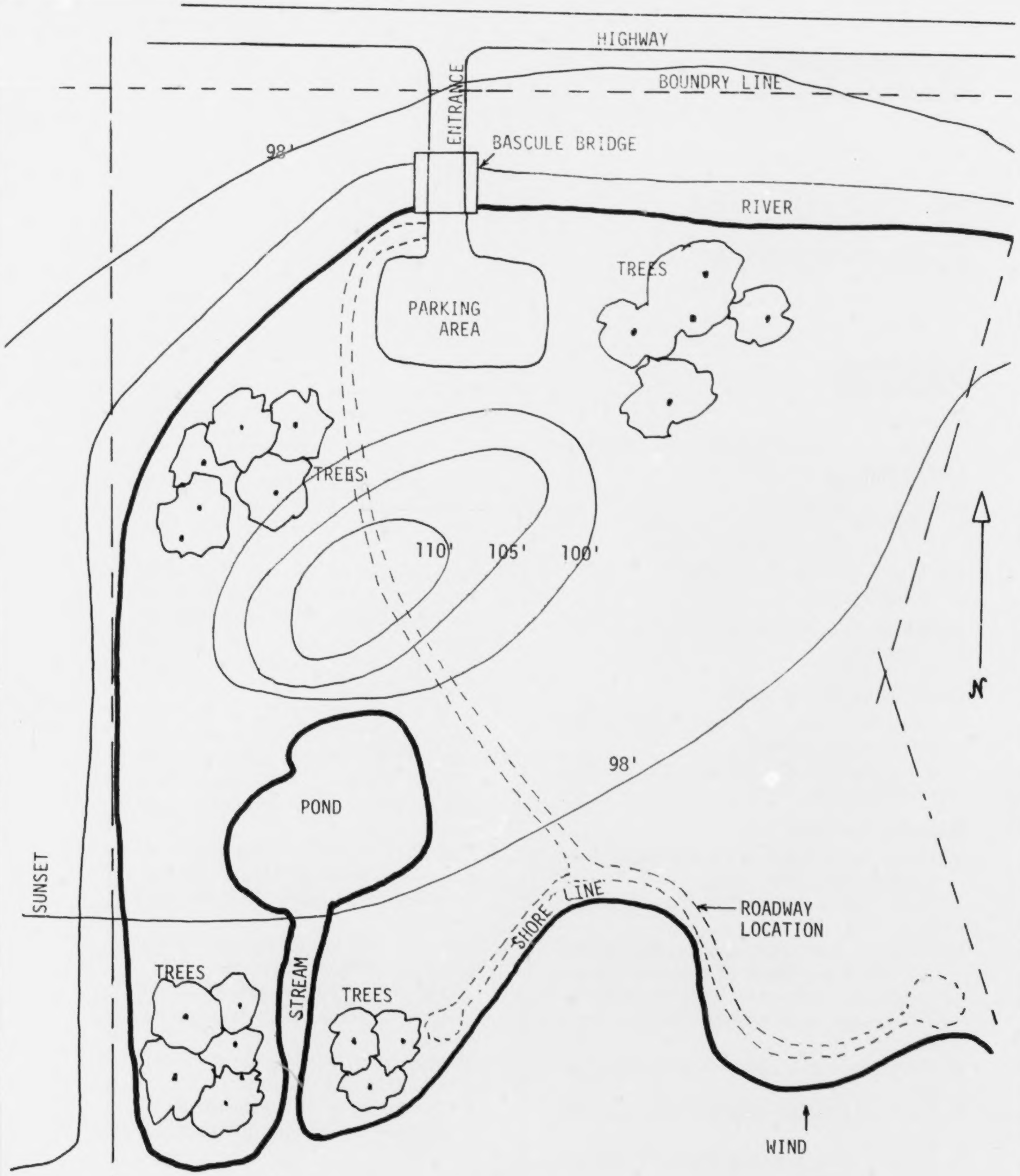
1. Carefully read the design situation described in Fig. 18-1.
2. Study the new Site Plan for the Community Park, Fig. 18-2.

### Refining the Idea

3. Paper clip a sheet of tracing paper over the Site Plan (Fig. 18-2).
4. Study your original Site Plan from Activity 13A.
5. Compare your original Site Plan to the new Site Plan. Think of how you can redesign and refine the ideas to meet the new design requirements. See Fig. 18-1, Item 2.
6. Sketch your new ideas on the tracing paper.
7. Have your teacher approve your new Site Plan.
8. Turn in your sketches when the teacher calls for them.

Fig. 18-1. Design Situation

a. Little progress has been made by the Park Planning Committee in the last year. They were not able to reach a decision on the park design.
b. In the meantime, the City Recreation Department has built a roadway on the Park Site so that people of the community can get to the lake for boating, fishing, and swimming. See Fig. 18-2.
c. With more people going to the park site, the City Council now wants the rest of the park developed, but the present designs for the park show areas and structures where the roadway now exists.
d. Therefore, the Park Planning Committee has hired an expert designer to redesign the park. You are that designer.
e. The new park design must meet certain requirements. These are:
   1. There must be the same kinds and sizes of areas as on the original plan.
   2. There must be the same structures as on the original plan.
   3. The location of areas must be changed to accommodate the roadway.


HIGHWAY
BOUNDRY LINE
ENTRANCE
BASCULE BRIDGE
98'
RIVER
TREES
PARKING AREA
TREES
110'
105'
100'
N
98'
POND
SUNSET
SHORE LINE
ROADWAY LOCATION
TREES
STREAM
TREES
WIND
0
100
UNITS

Lake Hope Site Plan for Community Park

Fig. 18-2.

ACTIVITY 19

# Selecting a Builder

Today you will work in one of four groups. You will help prepare arguments for one kind of contract. Then all four groups will compete for a painting contract.

## Problem

### Objective:

Given a construction job, select an appropriate type of construction contract and give reasons for the selection.

### Planning

1. Your group will plan ways to convince a buyer (the teacher) that you should be awarded a $50,000 painting contract. Study Figs. 19-1 and 19-2 and select a contract. Spend 10 minutes developing reasons why your form of contract is best.
2. Here are some suggested questions for help in preparing arguments.
   a. Can your kind of contract save the buyer money? If so, how?
   b. Can it save the buyer time? Why?
   c. Will your kind of contract mean less risk for the buyer?
   d. Are you sure of making some profit? (The buyer may not care, but you cannot afford to sign a contract if you are very likely to lose time and money.)
   e. If you are taking a risk, do you stand a chance to earn a good profit? (Again, the buyer may not care, but you must know what is involved.)

### Reporting

3. Your group will have 5 minutes to present arguments and reasons why the buyer should sign your contract. The whole group may take part, or one person may speak for the group.
4. After the reports, the buyer will award the contract based on the best argument.

Fig. 19-1. Construction Contracts

The following are examples of advantages for each kind of contract:

a. **Fixed price contract:** The owner will never have to pay more than the original contract price, even if the contractor has unexpected costs for labor or materials. The contractor will make extra money if he finds ways to cut costs.

b. **Cost - plus - fixed - fee contract:** The contractor does not pay anything extra if the project costs more than he had figured in labor or materials. The contractor's profit is untouched by rising costs of labor and materials.

c. **Cost - plus - percentage - of - cost contract:** The plans do not need to be completely detailed in advance because, whatever the final cost, the contractor will be paid based on how much work was done.

d. **Incentive contract:** Both the owner and the contractor can gain if the work goes well. Both can lose if it does not.

Fig. 19-2. Price and Profit Figures For Four Kinds of Construction Projects

**Situation:** A construction contractor has completed a project. His actual cost to do the job was $50,000. Before the project was built, the contractor had estimated that the price to the owner would be $70,000.

The contractor's profit will depend on what kind of contract he signed and what amounts were stated in the contract.

| Terms of Contract | Contractor's Profit | Price to Owner |
|---|---|---|
| Fixed price:<br>owner pays $70,000 | $70,000 price<br>−50,000 cost<br>$20,000 profit | $70,000 (fixed price) |
| Cost-plus-fixed-fee:<br>contractor gets $10,000 | $10,000 (fixed profit) | $50,000 cost<br>+10,000 profit<br>$60,000 price |
| Cost-plus-percentage-of cost: contractor gets 20% of cost | $50,000 cost<br>× .20 percent<br>$10,000.00 profit | $50,000 cost<br>+10,000 profit<br>$60,000 price |
| Incentive (three parts):<br>a. Working price is $70,000 based on cost estimate plus $10,000 profit to contractor | a. $10,000 profit | a. $70,000 price |
| b. If actual price to owner is more than $70,000, contractor gets only his percentage | b. $10,000 profit | b. Actual cost pl<br>$10,000 profit |
| c. If actual price to owner is less than $70,000, contractor gets his fee and splits savings equally with the owner. | c. $70,000 (estimate)<br>−50,000 (actual cost)<br>$20,000 (savings)<br>½ of savings: $10,000<br>plus fee: 10,000<br>profit: $20,000 | c. $50,000 cost<br>−10,000 savings<br>40,000<br>+10,000 profit<br>$50,000 price |

## ACTIVITY 20

# Contracting

## Problem 1

### Objective:

Given contracting procedures, bids, and a contract form:

a. Select a bidder.
b. Complete the contract form.
c. Answer questions related to bid selection and contract accuracy.

### Situation

Take the part of the head of a family who wishes to have a home built. You want a ranch style, seven-room house with a full basement. You want it to be well constructed and attractive. You must have it ready to move into within 6 months.

### Selecting a Bid

1. Shown below are three companies and their bids for building the house. Select the bid which you believe is the best lowest responsible bid.

**Bid A:** Blue and Grey House Construction Company

a. Estimated total cost: $20,000.
b. Bid bond: none.
c. Qualifications listed: none; this company is new in the city.
d. How long construction will take: 2 months—will start today.

**Bid B:** J. Thompson Construction

a. Estimated total cost: $25,000
b. Bid bond: guaranteed by Duck National Insurance Company
c. Qualifications listed:
    1. Has built good homes in area for 23 years.
    2. Assets: $250,000.
    3. Management and workers experienced in home building.
d. How long construction will take: 4 months—will start in 3 days.

**Bid C:** Brown Construction Company

a. Estimated total cost: $28,000.
b. Bid bond: guaranteed by Lloyds of London Insurance, Ltd.
c. Qualifications listed:
    1. Has built fine homes in the area for 10 years.
    2. Assets: $400,000.
    3. Management and workers experienced in home building.
d. How long construction will take: 5 months—will start in 1 week.

### Completing Contract

2. After selecting a builder, it is necessary for both parties to sign a contract agreeing on the type of work and the amount of money.
    a. Complete the contract form. See Fig. 20-1. Use your name as the owner's. Ask other class members to sign as the "contractor" and "witnesses."
    b. Carefully check the completed contract form for errors.
    c. Answer the "Questions."

### Questions

1. Did you select the lowest bid?

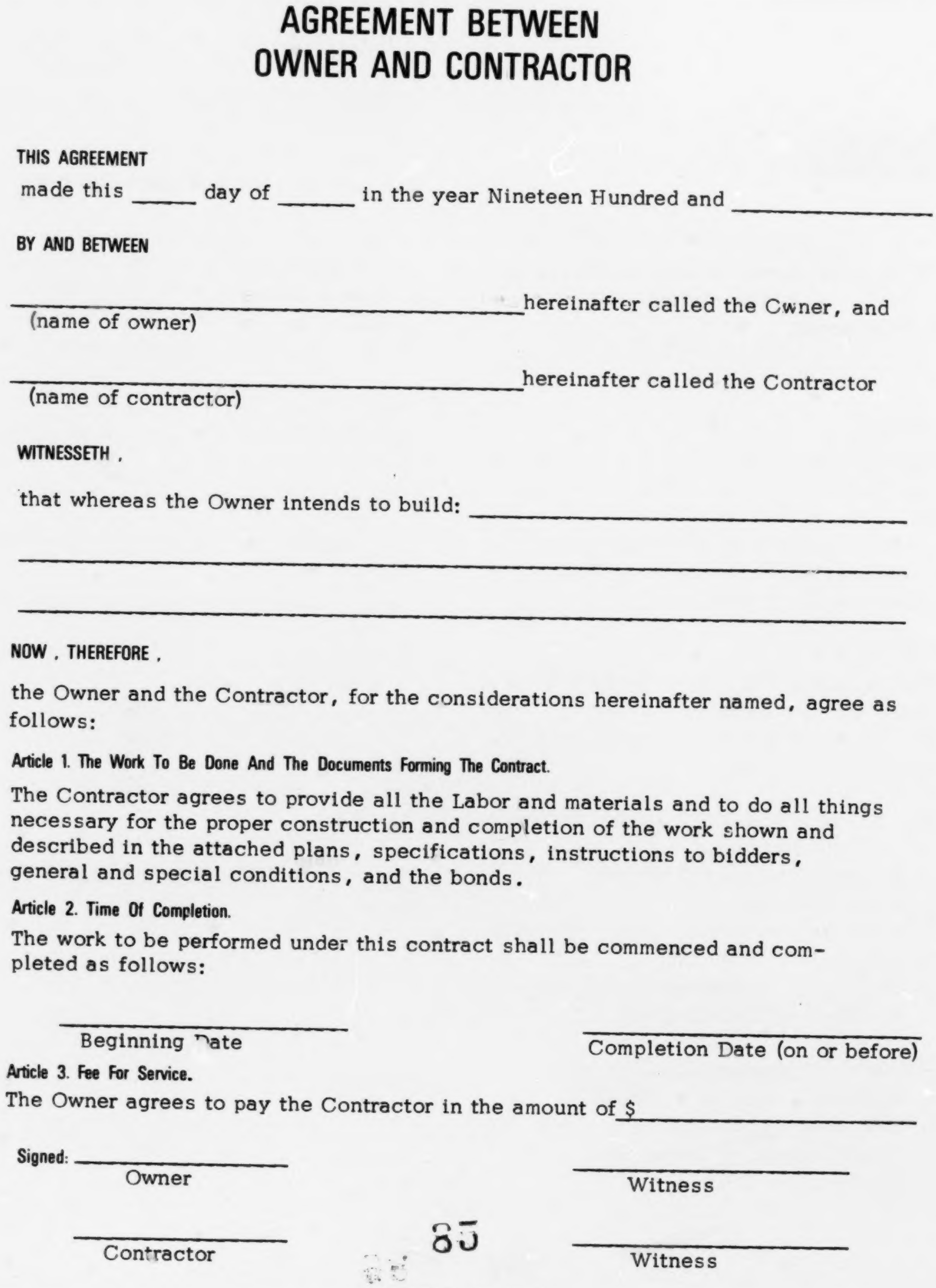
____ Yes ____ No

2. If you did not select the lowest bid, explain why.

3. Why is the accuracy of the contract important? ______________________________

______________________________ ______________________________

______________________________ ______________________________



## AGREEMENT BETWEEN
## OWNER AND CONTRACTOR

**THIS AGREEMENT**

made this _____ day of ______ in the year Nineteen Hundred and ______________

**BY AND BETWEEN**

______________________________ hereinafter called the Owner, and
(name of owner)

______________________________ hereinafter called the Contractor
(name of contractor)

**WITNESSETH ,**

that whereas the Owner intends to build: ______________________________

______________________________________________

______________________________________________

**NOW , THEREFORE ,**

the Owner and the Contractor, for the considerations hereinafter named, agree as follows:

**Article 1. The Work To Be Done And The Documents Forming The Contract.**

The Contractor agrees to provide all the Labor and materials and to do all things necessary for the proper construction and completion of the work shown and described in the attached plans, specifications, instructions to bidders, general and special conditions, and the bonds.

**Article 2. Time Of Completion.**

The work to be performed under this contract shall be commenced and completed as follows:

______________________ ______________________
Beginning Date Completion Date (on or before)

**Article 3. Fee For Service.**

The Owner agrees to pay the Contractor in the amount of $ ______________

**Signed:** ______________________ ______________________
Owner Witness

______________________ ______________________
Contractor Witness

Fig. 20-1. Contract

**ACTIVITY 21A & B**

# Estimating and Bidding

**Problem**

## Objective:

Given a plumbing plan, plumbing costs, and the choice of installing either a galvanized iron or copper tubing plumbing system, estimate which system will give you the most profit.

## The Situation

1. You have contracted to do a plumbing job for $400. The contract calls for the plumbing system to be either galvanized iron pipe or copper tubing.
2. Estimate which type of plumbing system will cost the least, thus giving you more profit.

## Estimating Material Costs

3. Study Fig. 21A-1, Plumbing Plan. Locate the plumbing lines, elbows and T's. Study Fig. 21A-2. You will enter your figures in Fig. 21A-2.
4. Add the number of feet in the plumbing lines. Record this figure on line 1 and multiply by the unit cost.
5. Count the number of elbows. Record this figure on line 2 and multiply by the unit cost to find the cost.
6. Count the number of T's. Record this figure on line 3. Figure the cost.
7. Add up the cost column to total the material costs. Enter this figure on line 4 and line 10.
8. Line 5 shows how much line can be installed by one man in an 8 hour work day. This includes connections.
9. Divide the number of feet in the line (from line 1) by the number of feet that can be installed in a day. Enter this figure on line 6.
10. On line 7, multiply the number of days times 8 hours per day to find the number of work hours. Enter this figure on line 7.

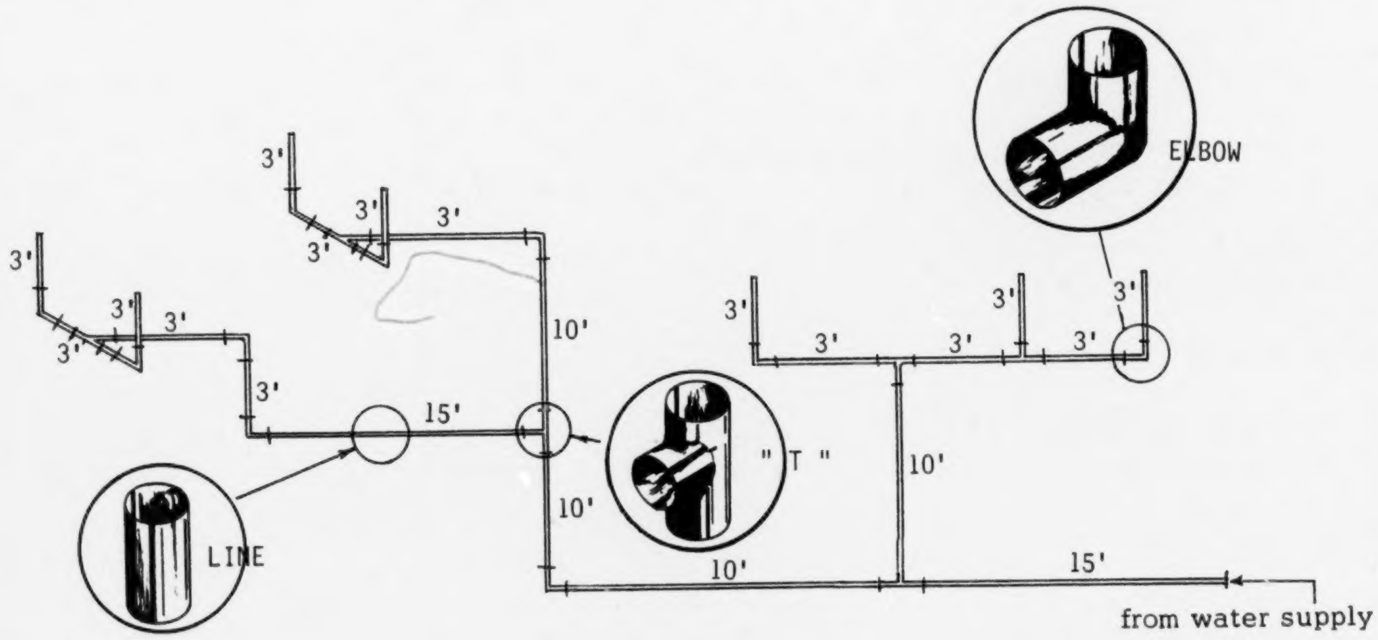


Fig. 21A-1. Plumbing Plan

11. The plumbers wages per hour are shown on line 8.
12. Multiply line 7 by line 8 to find the cost of labor. Enter this figure on line 9.
13. Add lines 9 and 10 to find the total cost of the job. Enter this figure on lines 11 and 13.
14. Line 12 shows the contract price.
15. Subtract the cost of the job (line 13) from the contract price (line 12) to find the estimated profit (line 14).
16. Which type of plumbing system would you install?

____________________

17. The buyer liked your work and intends to contract you for 100 more identical plumbing jobs for an apartment complex he is building. What will be your estimate of profit on 100 jobs?

____________________

Fig. 21A-2. Cost Estimate

| | ½″ Galvanized iron pipe | | | ½″ copper tubing | | |
|---|---|---|---|---|---|---|
| **Materials** | **Unit Cost** | **Q'nty** | **Cost** | **Unit Cost** | **Q'nty** | **Cost** |
| 1. Cost of line per ft. | $.15 × | ______ | = $______ | $.25 × | ______ | = $______ |
| 2. Cost per elbow | .10 × | ______ | = $______ | $.20 × | ______ | = $______ |
| 3. Cost per "T" | .15 × | ______ | = $______ | .30 × | ______ | = $______ |
| 4. Total Materials Cost | | | $______ | | | $______ |
| **Labor** | | | | | | |
| 5. Number of feet installed per 8 hr. day | | | 30′ | | | 40′ |
| 6. Number of 8 hr. days to do job | | ______′ / 30′ | = ______ | | ______′ / 40′ | = ______ |
| 7. Total work hours = number of days (line 6) × 8 | | | = ______ | | | ______ |
| 8. Plumbers wages per hr. | | | × $ 9.00 | | | × $ 9.00 |
| **Cost** | | | | | | |
| 9. Total cost of Labor | | | $______ | | | $______ |
| 10. Cost of Materials | | | + ______ | | | + ______ |
| 11. Total cost of job | | | $______ | | | $______ |
| 12. Contract price | | | $400.00 | | | $400.00 |
| 13. Cost of job | | | – ______ | | | – ______ |
| **Estimated Profit** | | | | | | |
| 14. Estimated profit | | | $______ | | | $______ |

**ACTIVITY 21C**

# Estimating and Bidding

**Problem 1**

### Objective:

Given a room plan, painting costs, and the choice of painting the room by brush or roller, estimate which painting technique will give you the most profit.

### The Situation

1. Mr. Jones has asked you to paint his room, and he wants you to give him an estimate. You would like to make $10 profit over your labor and material costs. You have a brush and a roller, but you don't know which one would be the most efficient (apply the most paint in the least amount of time and with the least effort.)
2. Estimate how much you would charge Mr. Jones so that you make $10 profit. Determine which painting technique is most efficient based on the information in Fig. 21C-2.

### Estimating

3. Study Fig. 21C-1, Room Plan, and Fig. 21C-2, Painting Estimate.
4. Figure the square feet of each of the walls and record the figures on lines 1, 2, 3, and 4. Total the surface area on line 6.
5. Figure the total square feet of openings and enter this figure on line 7.
6. Subtract the total opening area from the total surface area to find the total painting surface.
7. Read line 9. This is a "rule of thumb."
8. Figure how many hours it will take to paint the area by brush and by roller. Read line 10.
9. Your labor costs (by "rule of thumb" for painters) are $4.60 per hour by brush or $4.80 per hour by roller.
10. Figure the total labor costs on line 12. (Cost of labor per hr. x hrs.)
11. Add the cost of paint to find the painting estimate.
12. Which painting technique is more efficient?

    ____ roller ____ brush
13. How much would you charge Mr. Jones so you will make $10 profit over your labor and materials cost?

    $________

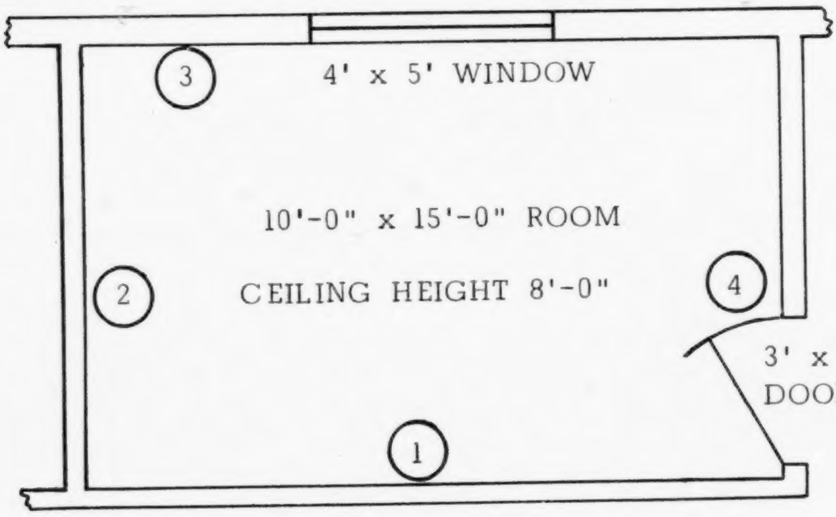


Fig. 21C-1. Room Plan

Fig. 21C-2. Painting Estimate

Surface Areas

**Walls** length × height = sq. ft. **Openings** width × height = sq. ft.

1. 1 ______ × ______ = ______ sq. ft. window ______ × ______ = ______ sq. ft.

2. 2 ______ × ______ = ______ sq. ft. door ______ × ______ = ______ sq. ft.

3. 3 ______ × ______ = ______ sq. ft. Total opening = ______ sq. ft.

4. 4 ______ × ______ = ______ sq. ft.
5. **Ceiling** 10′ × 15′ = 150′ sq. ft.

6. Total Surface Area = ______ sq. ft.

7. Total Opening Area = ______ sq. ft.

8. Total Painting Surface = ______ sq. ft.

Labor and Materials Costs

| | **By Brush** | **By Roller** |
|---|---|---|
| 9. Average area painted per hour | 150 sq. ft. | 300 sq. ft. |
| 10. Number of hours to paint 500 sq. ft. | ______ hrs. | ______ hrs. |

Divide: $\frac{500 \text{ sq. ft.}}{150 \text{ sq. ft.}}$ and $\frac{500 \text{ sq. ft.}}{300 \text{ sq. ft.}}$ (approx. area)

| | | |
|---|---|---|
| 11. Labor cost per hour | $ 4.60 per hr. × | $ 4.80 per hr. |
| 12. Total labor cost | ______ | ______ |
| 13. Cost of paint | $ 6.00 | $ 6.00 |
| 14. **Painting Estimate** | $______ | $______ |

ACTIVITY 22

# Scheduling

Two management procedures that contractors use to schedule work efficiently are (a) the *Bar Chart Procedure* and (b) the *Critical Path Method.* When you have completed this activity, you should be able to explain why work schedules are necessary and how they are developed.

## Problem 1

### Objective:

Given the problem of scheduling a sidewalk repair and the time required to do each task, complete the scheduling of a project using the Bar Chart Procedure.

### Task Requirements for Sidewalk Repair

Below are the tasks to be done in repairing a city sidewalk and the amount of time required to do each task.

| Task | Time |
|---|---|
| 1. Obtain building permit | ½ hr. |
| 2. Remove old concrete | 2 hrs. |
| 3. Level, fill, and grade | 1 hr. |
| 4. Order concrete | ½ hr. |
| 5. Build forms | 2 hrs. |
| 6. Place reinforcing wire mesh | 1 hr. |
| 7. Place concrete | ½ hr. |
| 8. Obtain inspection | ½ hr. |
| 9. Finish concrete | 1 hr. |
| 10. Concrete curing time | 2 hrs. |
| 11. Remove forms | ½ hr. |
| 12. Backfill and landscape | 1 hr. |

### Completing a Bar Chart

1. Using the given information, mark in the blocks of time as shown in Fig. 22-1 according to how you would schedule the job. The first two jobs are already completed as examples.

## Problem 2

### Objective:

Given a critical path schedule and some ordered materials, schedule the delivery of materials for the project using the Critical Path Method.

### Scheduling Deliveries

1. Fig. 22-2 shows the Critical Path Method for scheduling construction of a concrete patio.
2. Find the box labeled "DELIVER FILL." Find also the task which makes use of the fill. Draw a line to connect the two boxes.
3. You have now scheduled delivery of the fill. Schedule also the delivery of wire mesh and concrete by connecting the right boxes.

Fig. 22-1. Bar Chart for Sidewalk Repair Job

| Required Activity or Task | Required Time in Hours<br>1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Obtain building permit | ▨ | EXAMPLE | | | | | | | | | | |
| Remove old concrete | | ▨ | ▨ | | | | | | | | | |
| Level, fill and grade | | | | | | | | | | | | |
| Order concrete (order early) | | | | | | | | | | | | |
| Build forms | | | | | | | | | | | | |
| Place reinforcing wire mesh | | | | | | | | | | | | |
| Place concrete | | | | | | | | | | | | |
| Finish concrete | | | | | | | | | | | | |
| Have concrete inspected | | | | | | | | | | | | |
| Cure concrete | | | | | | | | | | | | |
| Remove forms | | | | | | | | | | | | |
| Backfill and landscape | | | | | | | | | | | | |

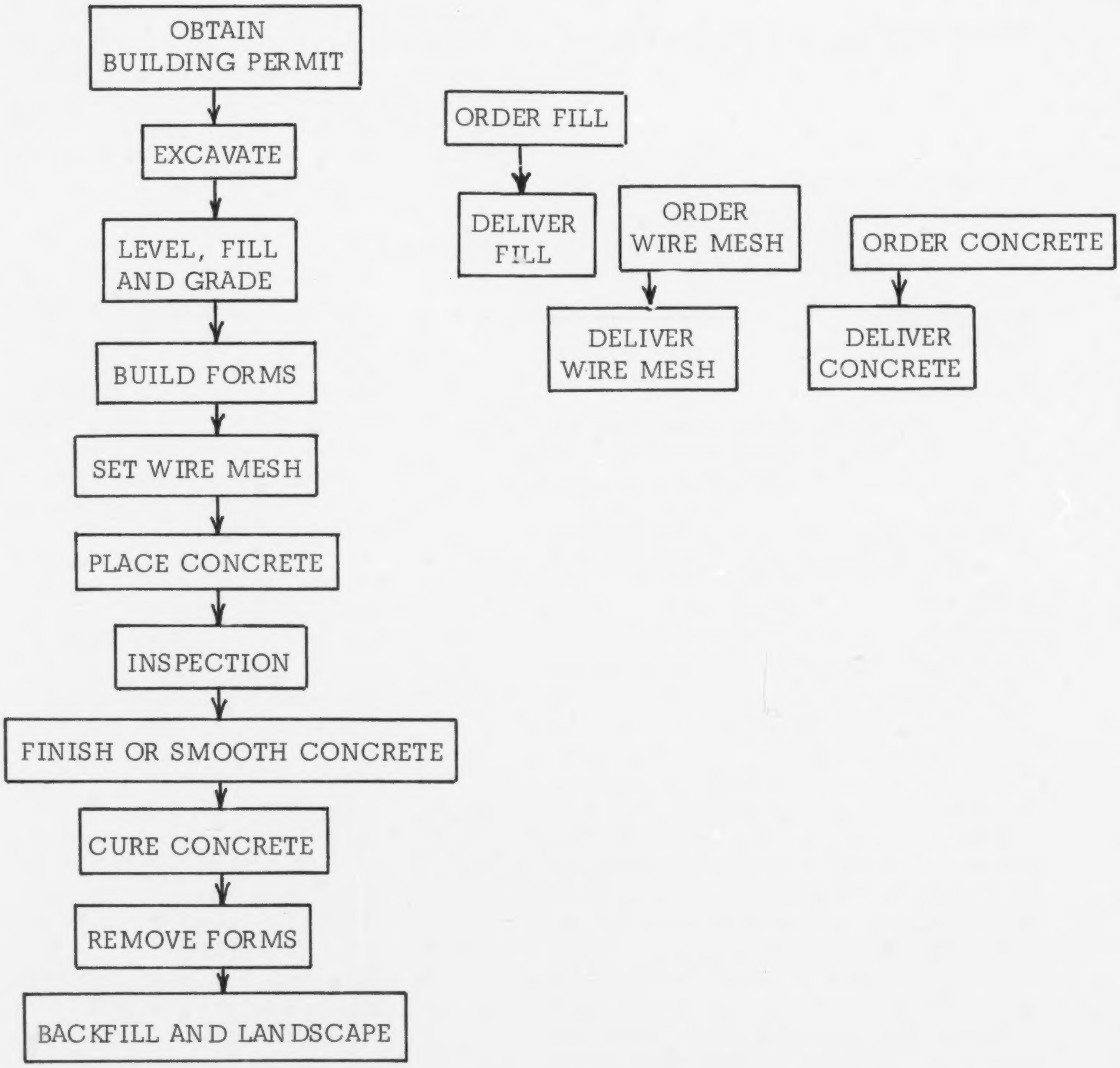

OBTAIN BUILDING PERMIT
EXCAVATE
LEVEL, FILL AND GRADE
BUILD FORMS
SET WIRE MESH
PLACE CONCRETE
INSPECTION
FINISH OR SMOOTH CONCRETE
CURE CONCRETE
REMOVE FORMS
BACKFILL AND LANDSCAPE
ORDER FILL
DELIVER FILL
ORDER WIRE MESH
DELIVER WIRE MESH
ORDER CONCRETE
DELIVER CONCRETE

Fig. 22-2. Critical Path Method for Scheduling Tasks

**ACTIVITY 23**

# Working as a Contractor

Today you will try to solve a problem that may happen while a construction job is in progress. You will make a series of decisions and then learn the outcome of your decision.

## Problem 1

### Objective:

1. Given a problem, decide whether to use materials other than those specified, or wait for the required material and pay a fine.
2. Given problems arising from the decisions made in the first problem, make two other decisions.

### Situation

You are a contractor who does general concrete work. You have contracted to build a swimming pool for a customer who demands that you finish the job before a certain date. If you do not finish by this date, you must pay a penalty of $100.

After you start the job, a serious problem comes up. A special concrete mix needed for the pool cannot be delivered until a week after the date you contracted to finish the job. You must think of a solution to this problem.

Remember that no matter what choice you make, your decision will create other problems that you must solve. After you have made a decision, you must follow it and deal with whatever problems it creates. *You cannot change your mind.*

The teacher will go over the first problem with you. Then you are to select either Decision 1 or Decision A. Place an X on the blank beside your decision.

After each decision wait for the teacher to read the next problem.

### Problem 1 (Summary)

You are informed that the special concrete usually used for swimming pools will not be available until a week after you had scheduled it. Thus, you will not have the swimming pool completed in time. You must pay a $100 penalty if you do not meet the deadline. Go to 1 or A and make a decision.

### Decision 1 or A

____ 1 Wait for the special concrete and tell the owner why you will not meet the deadline. If you check this choice go to 2 or 22. Your teacher will read the problem.

____ A Use a standard concrete, which is available immediately and will enable you to complete the job on time. If you check this choice, go to AA and wait.

____ 2 You can order special concrete from a city 50 miles away and finish on time, but the trucking cost will cut into your profit. Go to 3 or 33 and wait.

____ 22 You can rent special concrete equipment, buy the materials, and mix the concrete yourself. This cost will cut into your profit. Go to 4 or 44.

____ 3 Hire special concrete workers. This will cost you the rest of the money you have left for profit. You will finish on time with the job done correctly.

____ 33 Hire unskilled labor. This will still leave you with a profit. You will finish on time, but the job may not be done correctly.

____ 4 To finish on time you must tell your workers to work overtime, even though they are not obligated to do so. This will cost you the rest of your profit and the job may not be done correctly.

____ 44 Try to hurry your workers so they will finish during the normal working hours. This will leave you with a profit but may cause labor problems and the job may not be done correctly.

____ AA You have chosen Decision A. Wait for the teacher to read Problem B. Then go to B or BB.

____ B You can hire more men to rebuild the forms using heavier materials. The men and materials will decrease your profit on the job. Go to C or CC and wait.

____ BB You can rebuild the forms using the same men and materials, and add a special mixture to the concrete which will harden it more quickly. This mixture is inexpensive, but it is not guaranteed. Go to D or DD and wait.

____ C Hire skilled labor. This will cost you the rest of the money you have left for profit.

____ CC Hire unskilled labor. This will still leave you with a profit.

____ D You can try to patch the cracks with a thin layer of cement.

____ DD You can start all over.

Now that you have arrived at a final decision, your teacher will review the eight possible results of this decision-making process.

## ACTIVITY 24

# Collective Bargaining

## Problem 1

### Objective:

Given a labor management contract problem and acting as a union or management member:

a. Give reasons why a new contract *is or is not needed* when the old contract expires.
b. Negotiate for contract acceptance.

### Assignment to Groups

1. You will be assigned as a member of either management or a union by your teacher. Assemble with your group.
2. Choose two members of your group to be your spokesmen.

**Union**

3. Read the contract (agreement) you now have. See Fig. 24-1.
4. Read Fig. 24-3, Management Arguments. Read Fig. 24-2, Labor Arguments and compare your contract to the cost of living and other unions.
5. Decide, as a group, how your new contract should read. See Items A-E in Fig. 24-1. You have 10 minutes to decide.
6. The two spokesmen should present your new contract to management when called upon.

**Management**

3. Read the contract (agreement) you now have. See Fig. 24-1.
4. Read Fig. 24-2, Labor Arguments. Read Fig. 24-3, Management Arguments and compare your contract, the cost of living and other arguments.
5. Decide as a group how your new contract should read. See Items A-E in Fig. 24-1. You have 10 minutes to decide.
6. The two spokesmen should present your new contract to the union when called upon.

Fig. 24-1. Summary of Union Contract Agreements

**Local 68, United Association of Journeymen and Apprentices of the Bricklayers' and Masons' Industry of the United States**

A. Your wage scale is $4.50 per hour for 48 hours a week.
B. You receive double time for overtime.
C. You get $.06 per mile traveling expenses.
D. You pay your own accident insurance.
E. Your retirement plan calls for your receiving $200.00 per month upon retirement after age 62 and 30 years of service.

### Negotiating

7. The union spokesmen should present their reasons for the new contract to management.
8. The management spokesmen should present their reasons for the new contract to the union.
9. Determine the items in disagreement (Items A-E in Fig. 24-1).
10. You have 15 minutes to discuss and talk over these disagreements. All members join in the discussion to present counter arguments.

### Reconsidering Contract Agreements

11. After hearing the arguments, decide as a group what changes you will accept in the contract. You have 5 minutes to do one of the following:
    a. Agree to all of the terms and accept the new contract.
    b. Decide that the proposal should be

revised and be resubmitted and start negotiations again.

c. Stay with your original terms and elect to go on strike (union only) or close negotiations (management only).

12. Present your group decision to the other group.

Fig. 24-2. Labor Arguments

A. The cost of living has gone up 5% since the contract was signed last year. This cost of living represents an increase in prices of food, clothing, and other things you need.

B. Other unions have better benefits, such as:
   1. $400 per month retirement at age 60.
   2. 10 cents per mile traveling expenses.
   3. Double pay for overtime.
   4. Paid accident insurance.
   5. 35 hour work week.
   6. Wages range from $4.50 to $7.80 per hour.

Fig. 24-3. Management Arguments

**The cost of living has gone up 5% since the contract was signed last year. This cost of living represents an increase in prices of equipment, materials, rentals, insurance, and other things you must have to run your business.**

A. The contract they have now is a good one.

B. They just signed the contract a year ago.

C. The cost of living has gone up for you too, and you are short of money.

D. You don't get paid extra for overtime; why should they?

E. Why do they need high retirement benefits when they have social security?

F. They should drive in car pools so that travel expenses will not cost more than $.03 per mile.

G. They should be careful on the job; then they wouldn't need hospital insurance.

H. Sometimes you work more than 50 hours a week, so why can't they work 40, 44, or 48 hours?

I. Don't they have any concern at all for your business?

J. Is money all they can think of?

K. If they go on strike, they won't have any income. Then what will they do?

L. If they go on strike, you will hire other people in their place.

**ACTIVITY 25**

# Hiring Construction Personnel

Today you will play one of two roles: a personnel manager or a worker applying for a job. All students will draw cards from a stack to determine which role they will play.

**Equipment** (Per class)
1 set (8) Man Wanted signs
1 set (24) Job Applicant cards
1 set (8) Personnel Manager cards

**Supplies** (Each student)
1 pc. 8½″ x 11″ paper
1 pencil

## Selecting a Role

Select a card from a stack when told to do so by your teacher. On this card will be one of the two titles: "Job Applicant" or "Personnel Manager." If you draw a "Job Applicant" card, work Problem 1. If you draw a "Personnel Manager" card, work Problem 2.

## Problem 1

### Objective:

Given the role of a job applicant, apply at several companies for a job.

### Applying for a Job

1. You have drawn a Job Applicant card. On this card will be your trade or profession, number of years of experience, and the pay the average worker gets for this job.
2. Eight companies are hiring workers. Each company has a sign showing the kinds of workers wanted. Locate your job title on a "Man Wanted" sign and talk with the personnel manager about a possible job.
3. You may not talk to more than three personnel managers, but should talk with more than one before accepting a job. Try to get more money than that listed for the average worker on your card. But do not try for too large a salary; you could wind up with no job at all.
4. Record the following information:
   a. What salary did you agree to?

      ____________________

   b. Was it above or below the average or was it average for men doing your kind of work?

      ____________________

   c. How many personnel managers did you talk to?

      ____________________

   d. Which job did you take?

      ____________________

5. At the end of the laboratory activity you should compare your salary with other job applicants in your trade or profession to see who got the best job.

## Problem 2

### Objective:

Given the role of a personnel manager, interview and hire applicants applying for a job.

### Hiring

1. On your Personnel Manager card is a company name. Go to this company's booth.
2. The card lists your company's job needs and the salary or wage the company will pay for certain jobs.
3. During the laboratory period you may talk with any number of job applicants. However, you may hire only three men.
4. The importance of each job is rated by number: 1, 2, 3, 4, or 10. The higher

the number, the more important it is to your company to fill the job. Any job rated "10" should be filled as soon as possible.

5. You may raise or lower the original salary or wage for any job offered by the company. If a man is hired for more than the *value,* you lose a point. If a man is hired for less than the *value* you gain a point. The point values are shown on the Personnel Manager cards.
6. On a separate sheet of paper record all agreements made with workers. *Do not write on the card.*
7. At the end of the laboratory activity, add the number values of the jobs you have filled. The person with the highest total was the "most successful" personnel manager.

a. How many points did you get?

______________________

b. Did you have to raise wages or salaries?

______________________

c. How many men did you hire?

______________________

## Questions

Each question in Column I can be answered correctly by one of the phrases in Column II.

Column I

_____ 1. What does recruiting mean?
_____ 2. The recruiting is long and expensive when what kind of men are needed?
_____ 3. What starts this long and expensive recruiting process?
_____ 4. What department does hiring in a larger company?
_____ 5. The personnel manager recruits in what ways?

Column II

A. Training and directing
B. Special and well-trained men
C. Personnel
D. A request to hire a person to fill a job opening
E. Inducting
F. Finding and attracting possible employees
G. By advertising, placing job order with various agencies, or by checking with schools and colleges
H. Long and expensive

## ACTIVITY 26

# Training and Educating for Construction

Today you will write parts of an agreement about an apprenticeship program for the construction industry.

## Problem

### Objective:

Given the problem of completing an apprenticeship program agreement:

a. Decide some of the requirements for a good apprenticeship training program.
b. Find a company in the telephone directory as an employer.

**Equipment** (Per class)
3 telephone directories

### Preparing to Work

1. Each group will be assigned a different construction trade. The foreman for the group will serve as chairman and lead the discussion.
2. Your committee will complete an apprenticeship program agreement. Your tasks will include the following:
   a. Set up a time period during which the apprentice is to get training and experience on the job.
   b. Set up a program of classroom instruction.
   c. Set up a wage schedule which shows that wages will increase as the apprentice gets more and more experience.
   d. Choose a company which has the trained workers and equipment to give the apprentices suitable on-the-job-training.
3. Use the information in Fig. 26-1 to help you make wise decisions.

### Completing the Statements

4. Fig. 26-2 is a summary agreement about an apprenticeship program with several parts omitted. Fill in all the blanks.
5. Use a telephone directory to find the name of a construction firm in the trade assigned to you. Use this name to complete the "Employment" blank.

Fig. 26-1. Requirements for Good Apprenticeship Training

1. **Length of training:** approximately 2,000 hours a year for 4 years.
2. **Classroom instruction:** approximately 144 hours per year.
3. **Some major areas of training:** electrical, carpentry, cement finishing, ironworking, plastering, plumbing, operating engineer.
   a. Layout
   b. Rough-in work
   c. Finishing
   d. Care and use of tools and machinery
   e. Estimating
   f. Safety
   g. Other special training
4. **Wages:** Begin at 50% of journeyman's wages in the area, then increase at the rate of 25% of the beginning salary every year. Nationally, the average journeyman's wage is $4.00 per hour.
5. Hours of work and working conditions should be the same as those of the journeyman.
6. At no time should the on-the-job apprentice training interfere with the classroom instruction.

A. The construction trade for which this program is being written is the

______________________________

B. The period of apprenticeship shall be

__ (how many years)

C. The major training areas to be included are (select items from a-g, Fig. 26-1)

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

______________________________

D. Wage increases per hour are:

1st year $____ (50% of Journeymen's wages)

2nd year $____(15% of Journeymen's wages plus 1st year's wage)

3rd year $____ (15% of Journeymen's wages plus 2nd year's wage)

4th year $____ (15% of Journeymen's wages plus 3rd year's wage)

E. Hours of work and hours of approved instruction are as follows:

1. The workday and workweek of the apprentice shall be the

   ____ as those of a journeyman.
2. The apprentice shall enroll and attend classes the number of hours established by the group. These should be approximately

   ____ hours per year.
3. At no time shall the work assigned interfere with the related assignment.
4. Employment: The group chooses the

   ______________________________

   (a local contractor) as the employer of the apprentice.

Fig. 26-2. Summary Agreement on Apprenticeship Program

**ACTIVITY 27**

# Working Conditions

Certain information must be considered in establishing working conditions between the employer and his employee. Today you will work with this kind of information.

**Problem**

## Objective:

Given a job title and a specific task, write a set of rules governing working conditions in the laboratory.

**Supplies** (Each student)
1 sht. paper

1. Your teacher will direct you to work in a committee to develop an agreement about working conditions. The committees will be made up as follows:
   **1st Committee:** Foremen
   **2nd Committee:** Timekeepers
   **3rd Committee:** Equipment Supervisors
   **4th Committee:** Safety and Grievance Men
   **5th Committee:** Recorders
2. On Fig. 27-1 find the directions that apply to your committee. Read the directions and perform the tasks as outlined.
3. When your committee has agreed on a set of suggested solutions to the problems, copy them neatly on a sheet of paper. Have each member sign the sheet and turn it in to your teacher.

Fig. 27-1. Committee Tasks

| Committee Number | Writing Tasks |
|---|---|
| 1<br>Foremen | List the problems your group and other groups have had in getting work done. These might include problems of: getting and storing materials, working together as a group, how work will be done when a class member is absent, and other problems you have seen. Suggest possible solutions. |
| 2<br>Timekeepers | Outline the routine you think that class members should follow when starting and stopping work. Name some of the problems you have found and suggest solutions. |
| 3<br>Equipment Supervisors | Name some of the problems you have found when getting out or storing equipment and materials. Suggest solutions on how these problems can be solved. |
| 4<br>Safety and Grievance Men | Name some of the safety hazards in your laboratory and suggest what can be done about them. Make a list of five safety rules you think should be obeyed in your laboratory. |
| 5<br>Recorders | Name some of the problems you have had in recording and suggest possible solutions. Write the procedures to follow when a class member is late or absent. Who should he report to? How does he find out what work or information was missed? |

**ACTIVITY 28**

# Advancing in Construction

## Objective:

Given a list of tradesman's or professional occupations and important data, choose a trade or profession and find the appropriate total income for 5 years and 10 years after high school.

## Choosing An Occupation

1. Select a trade from Fig. 28-1 or a profession from Fig. 28-3 in which you are interested.
2. Those selecting a trade do Problem 1. Those selecting a profession are to do Problem 2.

**Problem 1**

## Finding Tradesman's Income

1. Enter the name of the trade you selected from Fig. 28-1 in line 1 of Fig. 28-2.
2. On line 2 record the wage rate/hr. Multiply the wage times .75 (75%).
3. Write the answer from line 2 on line 3. This is your average wage per hour while you are an apprentice.
4. On line 4 enter the years of apprenticeship.
5. On line 5 enter the earnings during apprenticeship.
6. Enter the journeyman's yearly wage on line 6.
7. On line 7 enter the earnings from the first 5 years of work.
8. On line 8 enter the earnings from 10 years of work.
9. Review your work while you wait for the teacher to ask you to report your findings to the class. Then you can discuss what you and your classmates have reported.

**Problem 2**

## Finding Professional Income

1. Enter the name of the technician or profession from Fig. 28-3 in line 1 of Fig. 28-4.
2. Enter the years of education on line 2.
3. *Professions only.* Enter $2,000 on line 3. This is cost of education for 1 year.
4. *Technicians only.* Enter $1,000 on line 3. This is cost of education for 1 year.
5. Multiply years of schooling by the annual cost to find the total cost of education. Enter this figure on line 4.
6. On line 5 enter the income during the first 5 years after high school.
7. On line 6 enter the yearly income during the second 5 years after high school.
8. On line 7 enter the total earnings during the second 5 years after high school.
9. Enter the 10-year earnings on line 8.
10. Review your work while you wait for the teacher to report your findings to the class. Then you can discuss what you and your classmates have reported.

| Trade | Rate/Hr. | Years of Apprenticeship | | Journeyman's Yearly Wage |
|---|---|---|---|---|
| Construction Laborer | $2.55 | No Education | None | $4,900 |
| Surveyor's Helper | 1.90 | High School | None | 3,700 |
| Welder | 3.15 | High School | None | 6,000 |
| Roofer | 4.28 | High School + | 3 years | 8,200 |
| Lather | 4.45 | High School + | 3 years | 8,500 |
| Equipment Operator | 4.80 | High School + | 3 years | 9,300 |
| Painter | 4.16 | High School + | 3 years | 7,900 |
| Glazier | 4.18 | High School + | 3 years | 8,000 |
| Cement Mason | 4.40 | High School + | 3 years | 8,400 |
| Bricklayer | 4.65 | High School + | 3 years | 8,900 |
| Floor Coverer | 3.85 | High School + | 4 years | 7,400 |
| Sheet Metal | 4.33 | High School + | 4 years | 8,300 |
| Plasterer | 4.55 | High School + | 4 years | 8,700 |
| Iron Worker | 4.69 | High School + | 4 years | 9,000 |
| Carpenter | 4.44 | High School + | 4 years | 8,500 |
| Electrician | 4.90 | High School + | 5 years | 9,400 |
| Plumber-Pipefitter | 4.95 | High School + | 5 years | 9,600 |

Figures here are based on union wages as they existed in Ohio in January, 1966. Wide regional differences exist. Total wages are also based on a full 12-month work period; 40 hours per week, 4 weeks per month.

▨ Apprenticeship

Fig. 28-1. Tradesmen's Education and Wages

Fig. 28-2. Tradesman's Income

Trade (1) ________

Wage per hr. (2) $ ____ × .75 = (3) ________ (average apprenticeship rate)

Number of years of apprenticeship (4) ________

Earnings during apprenticeship (average rate: line 3 × years, line 4 × 2,000 hrs./yr.) (5) ________

Journeyman's yearly wage (6) ________

5 year earnings (combination of lines 5 and 6) (7) ________

10 year earnings (add to line 7 the income from 5 years at the journeyman rate) (8) ________

Fig. 28-3. Semiprofessional and Professional Education and Salaries

| Technician | Rate /Hr. | Years of Schooling and/or Apprenticeship | Approximate Yearly Salary A | Approximate Yearly Salary B |
|---|---|---|---|---|
| Engineering Technician | Usually paid on a yearly basis. | High School + 2 years | $5,100 | $8,900 |
| Heating-Refrigeration Technician | | High School + 2 years | 5,100 | 8,900 |
| Surveyor | | High School + 2 years ▨ + 2 years | 5,600 | 9,700 |
| **Professional** | **Rate /Hr.** | **Years of Schooling and/or Apprenticeship** | **Approximate Yearly Salary A** | **Approximate Yearly Salary B** |
| Engineer | Usually paid on a yearly basis. | High School ░ + 4 years | $8,000 | $15,000 |
| Urban Planner | | High School ░ + 5 years | 7,500 | 15,000 |
| Architect | | High School ░ + 5 years | 8,600 | 25,000 |

░ College Education
▨ Apprenticeship
☐ Technical Education

Fig. 28-4. Professional Income

Profession (1) ______

Years of education after high school (2) ______

Cost of education for 1 year (3) $______

Total cost of education (4) $______

(____ × ________)
years annual cost

Income in first 5 years after high school (see Column A, Fig. 28-3) (5) $______

Yearly salary (from Column B, Fig. 28-3) (6) $______

Income in second 5 years (7) $______

(5 × ____________)
amount on line 6

10 year earnings (line 5 + line 7) (8) $______

**ACTIVITY 29**

# Construction Production Technology

## Problem 1

### Objective:

1. Given a list of production practices, classify them as preprocessing, processing, or postprocessing.
2. Given a list of processing practices, classify them as separating, forming, or combining.

### Classifying Production Practices

1. As the instructor writes a production practice on the board, you are to write it in Fig. 29-1.
2. The instructor will ask someone to classify each practice.
3. As the correct answer is agreed upon, check the proper box: preprocessing, processing or postprocessing in Fig. 29-1.

### Classifying Processing Practices

4. As the instructor writes a processing practice on the board, you are to write it in Fig. 29-2.

Fig. 29-1. Production Practices

|  | Production Practice | Classification<br>Preprocessing | <br>Processing | <br>Postprocessing |
|---|---|---|---|---|
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| 4. |  |  |  |  |
| 5. |  |  |  |  |
| 6. |  |  |  |  |
| 7. |  |  |  |  |
| 8. |  |  |  |  |
| 9. |  |  |  |  |
| 10. |  |  |  |  |
| 11. |  |  |  |  |
| 12. |  |  |  |  |
| 13. |  |  |  |  |
| 14. |  |  |  |  |
| 15. |  |  |  |  |

Fig. 29-2. Processing Practices

|  | Processing Practice | Classification<br>Separating | <br>Combining | <br>Forming |
|---|---|---|---|---|
| 1. |  |  |  |  |
| 2. |  |  |  |  |
| 3. |  |  |  |  |
| 4. |  |  |  |  |
| 5. |  |  |  |  |
| 6. |  |  |  |  |
| 7. |  |  |  |  |
| 8. |  |  |  |  |
| 9. |  |  |  |  |
| 10. |  |  |  |  |
| 11. |  |  |  |  |
| 12. |  |  |  |  |
| 13. |  |  |  |  |
| 14. |  |  |  |  |
| 15. |  |  |  |  |

5. The instructor will ask someone to classify the practice.
6. As the correct answer is agreed upon, check the appropriate box: separating, combining, or forming in Fig. 29-2.

**Problem 2**

## Objective:

Given the equipment and materials, construct a site box and seal the inside corners.

**Equipment** (Group of 5)

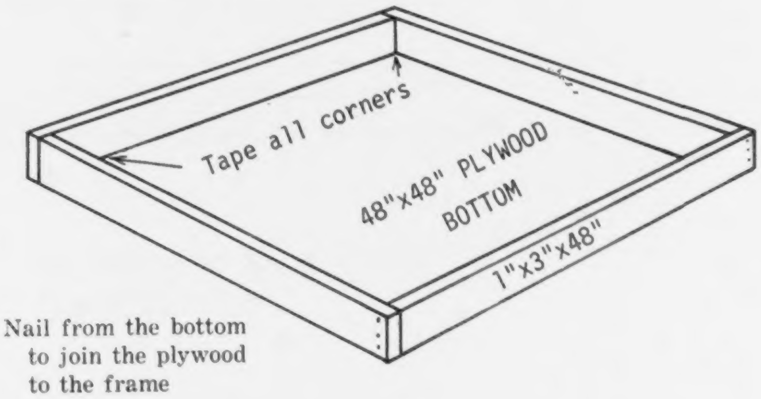
| | |
|---|---|
| 2 | claw hammers |

**Supplies** (Group of 5)

| | |
|---|---|
| 4 pcs. | 1" x 3" x 48" (approx.) pine |
| 1 pc. | ½" x 48" x 48" plywood |
| 1 roll | ¾" masking tape |
| 30 | 6d common nails |

## Assembling and Sealing the Box

1. Obtain the equipment and supplies for your group.
2. Construct the site box as shown in Fig. 29-3.
3. After the box is constructed, use masking tape to seal all the corners inside the box. See Fig. 29-3.



Nail from the bottom to join the plywood to the frame

Fig. 29-3. Site Box Construction

**ACTIVITY 30**

# Getting Ready to Build

Today you are going to locate utilities and place temporary facilities on a typical construction site.

**Problem 1**

## Objective:

Given a site box with sand, some nails, string, and a construction site plan, locate

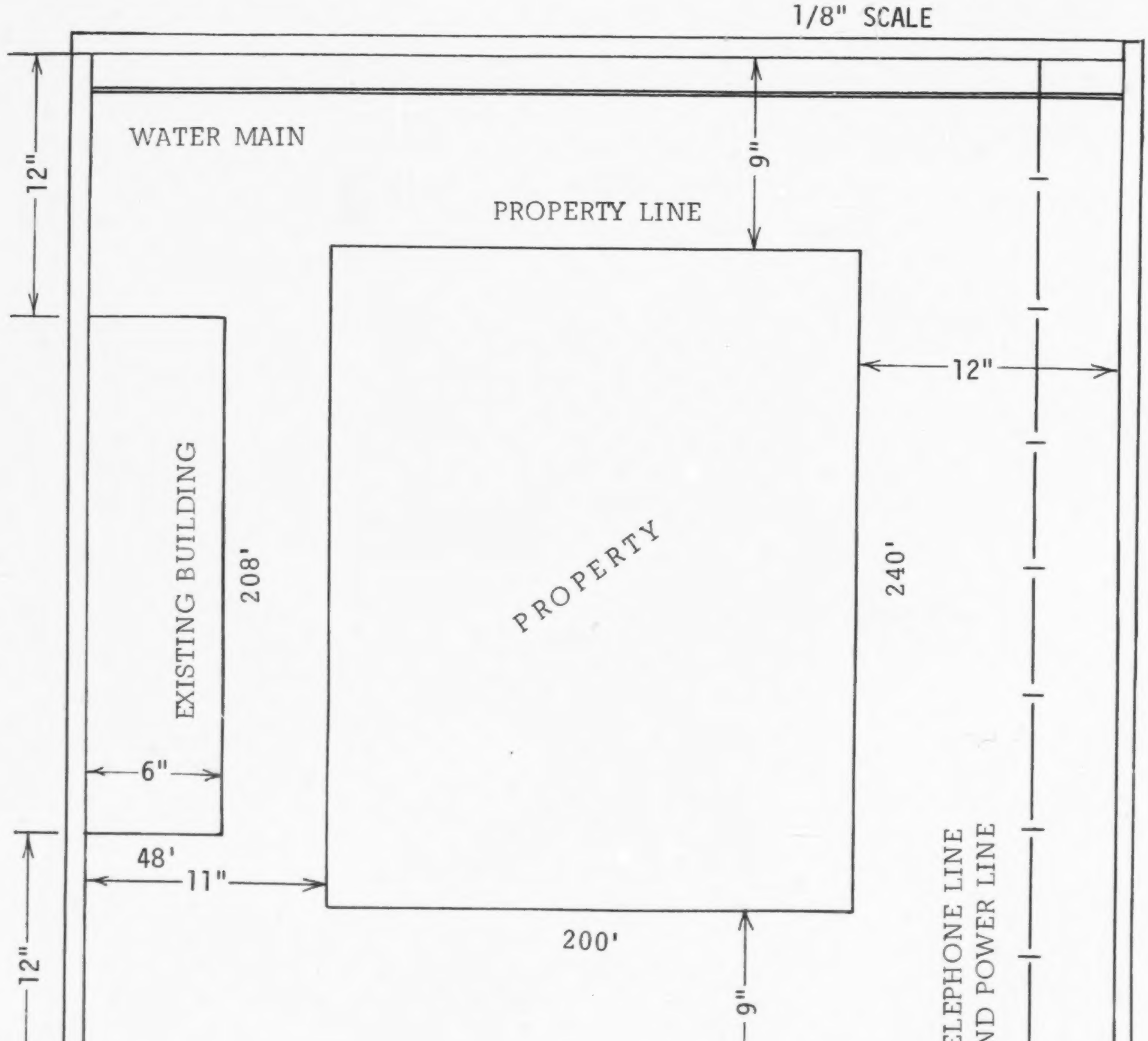

1/8" SCALE
WATER MAIN
PROPERTY LINE
9"
12"
12"
EXISTING BUILDING
208'
PROPERTY
240'
6"
48'
11"
200'
9"
12"
TELEPHONE LINE AND POWER LINE

Fig. 30-1. Construction Site Plan

buildings, water mains, telephone lines, roads, and property lines.

**Equipment** (Group of 5)
1 pr. scissors
2 claw hammers

**Supplies** (Group of 5)
1 construction site box
4 buckets of sand
1 12″ rule
2 lb. 6d common nails
9 yd. string

## Preparing to Work

1. Two members of your group do Problem 2 while the other members do Problem 1.
2. Fill the site box with 1″ of sand, and level the sand. Study the site plan before you begin. See Fig. 30-1.

## Locating Site Features

3. Start from any side, but be consistent.
4. Using nails, locate and mark the four corners of the property. See Figs. 30-1 and 30-2.
5. Using string, mark the location of the property. See Figs. 30-3 and 30-4.
6. Using nails and string, locate and mark the location of the existing building. See Figs. 30-1 and 30-5.
7. From Fig. 30-1, determine where the telephone lines are located. Measure 5″

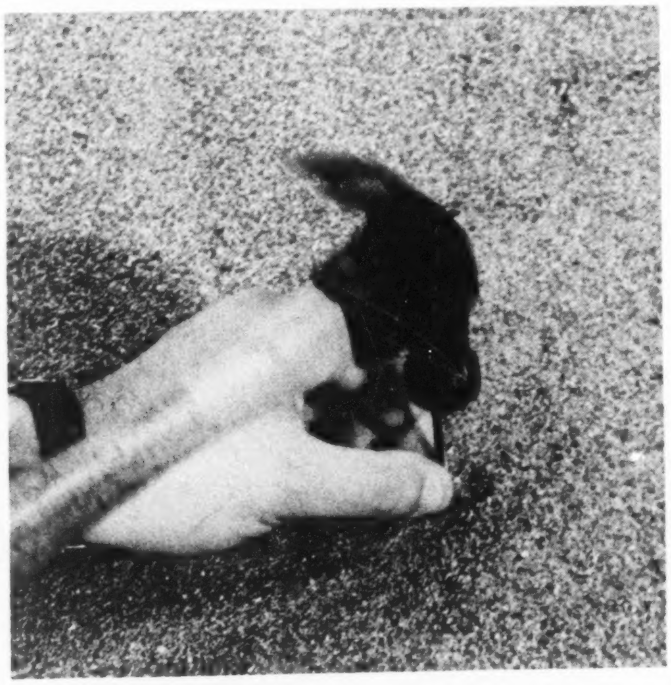


Fig. 30-2. Driving Corner Pins

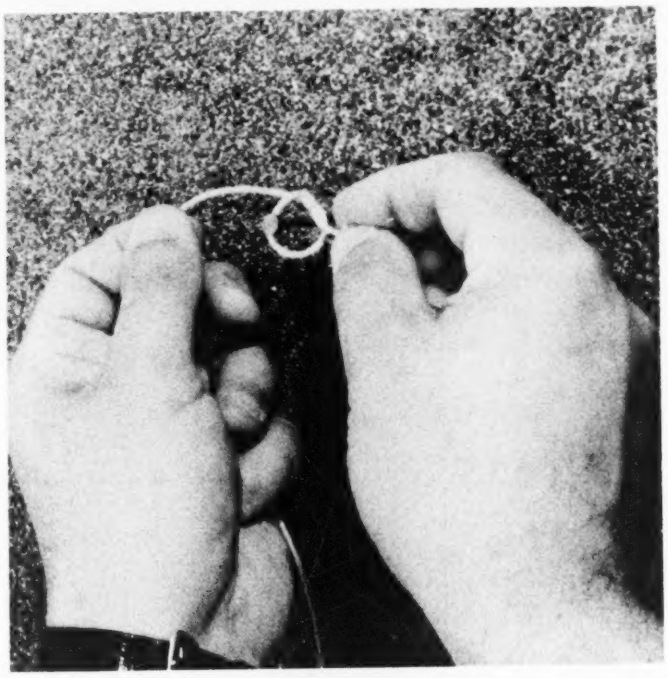


Fig. 30-3. Tying String

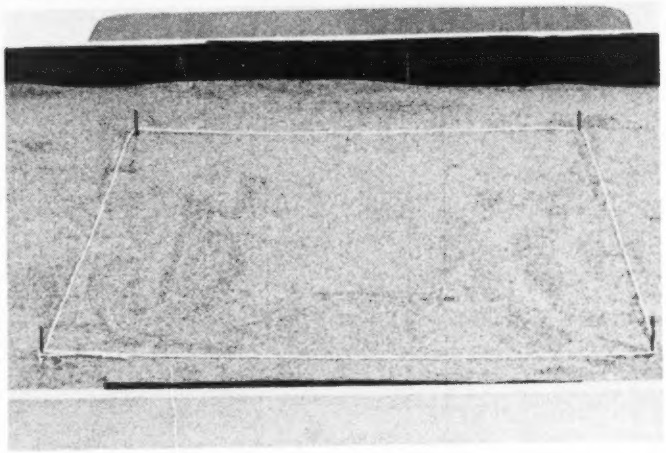


Fig. 30-4. Running Property Lines

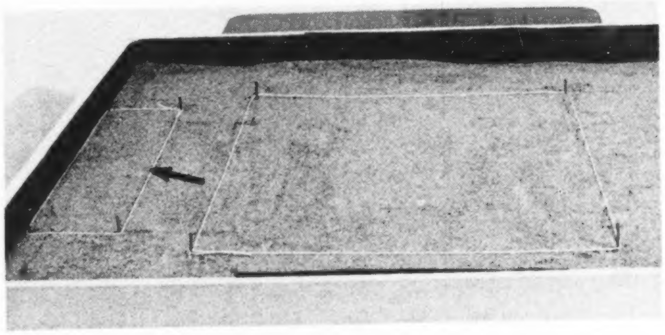


Fig. 30-5. Locating Existing Building

from the outside of the box. Tack the string in place to represent the telephone and power lines. See Fig. 30-6.

8. From Fig 30-1, determine where the water main is located. Measure in 2″ from the inside of the box; tack a string in place to represent the water main. See Fig. 30-7.
9. To lay out the location of the streets, measure in 8″ from the two sides that have the water main and telephone lines as shown in Fig. 30-8.
10. Mark the street location with nails and string. See Fig. 30-9.

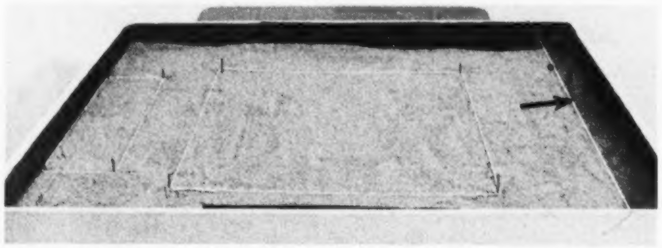


Fig. 30-6. Locating Telephone Lines

11. Place the building area in the middle of the construction site. See Fig. 30-10.

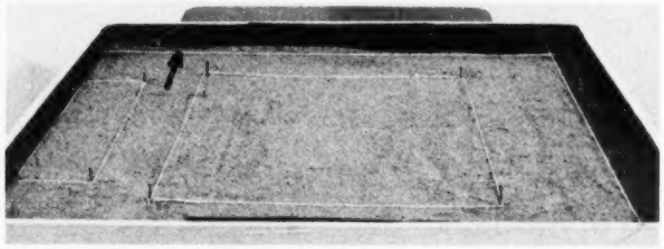


Fig. 30-7. Locating Water Mains

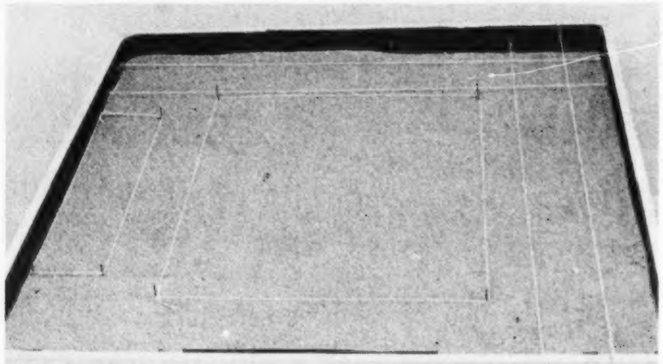


Fig. 30-9. Locating Streets

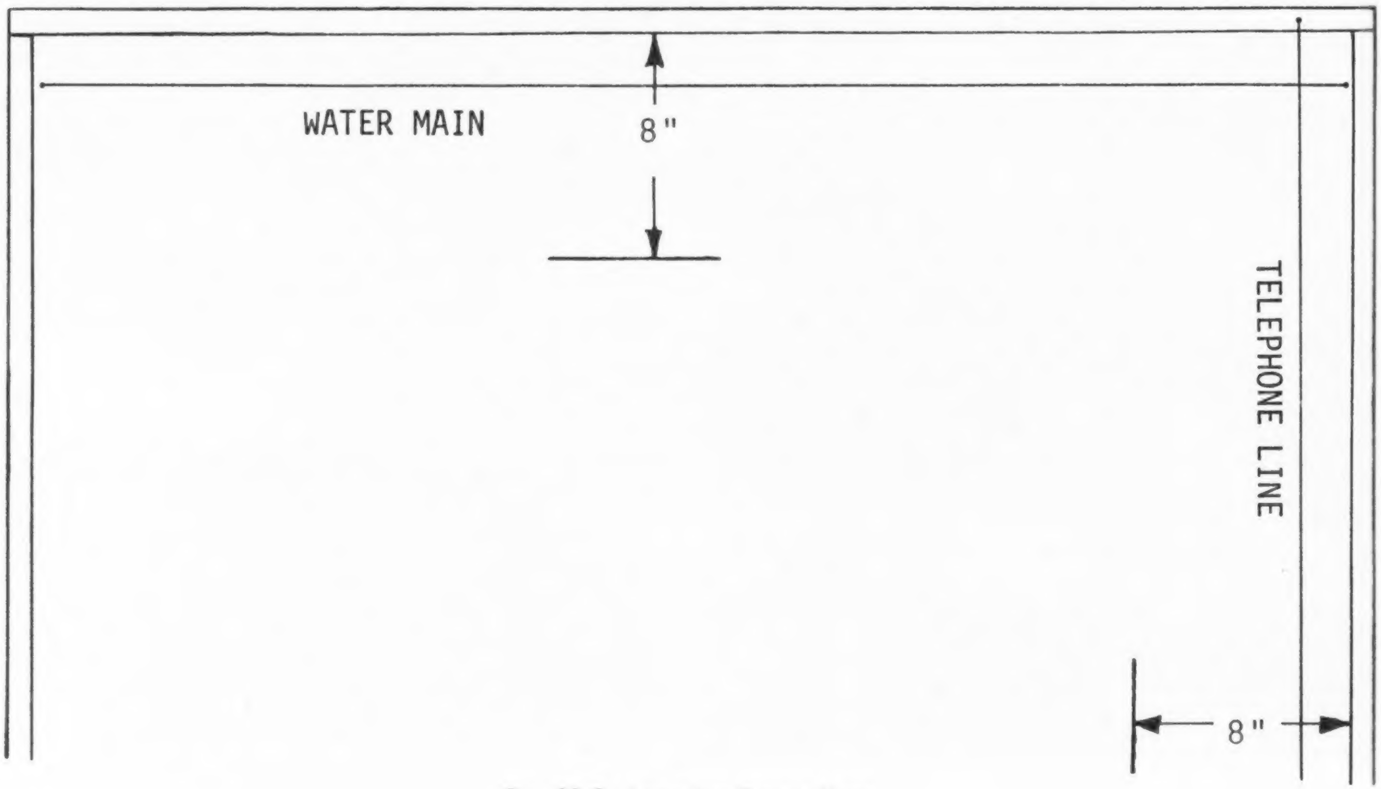


Fig. 30-8. Locating Street Lines

**Problem 2**

### Objective:

Given a site box with located buildings, property, and utilities, locate temporary facilities where they will be most efficient.

### Locating Facilities

1. Draw the temporary facilities shown in Fig. 30-11 on a separate sheet of paper. Follow the sizes shown in Fig. 30-11.
2. Label the facilities and cut them out with scissors.
3. As a group, you will lay out the location of temporary facilities and materials to be used on the construction site.
4. Arrange the temporary facilities on the

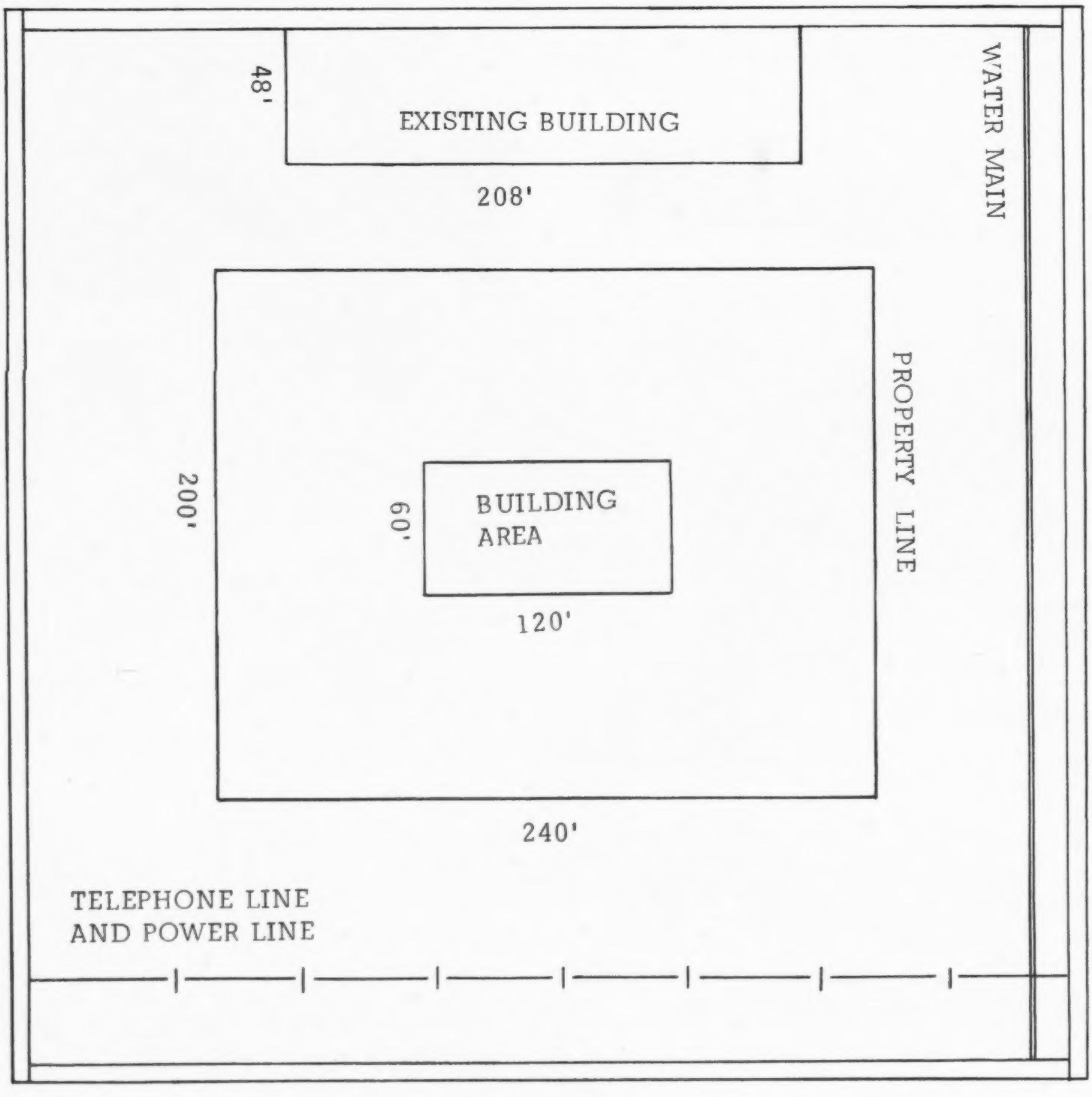

48'
EXISTING BUILDING
208'
WATER MAIN
PROPERTY LINE
200'
60'
BUILDING AREA
120'
240'
TELEPHONE LINE AND POWER LINE

Fig. 30-10. Locating Building Area

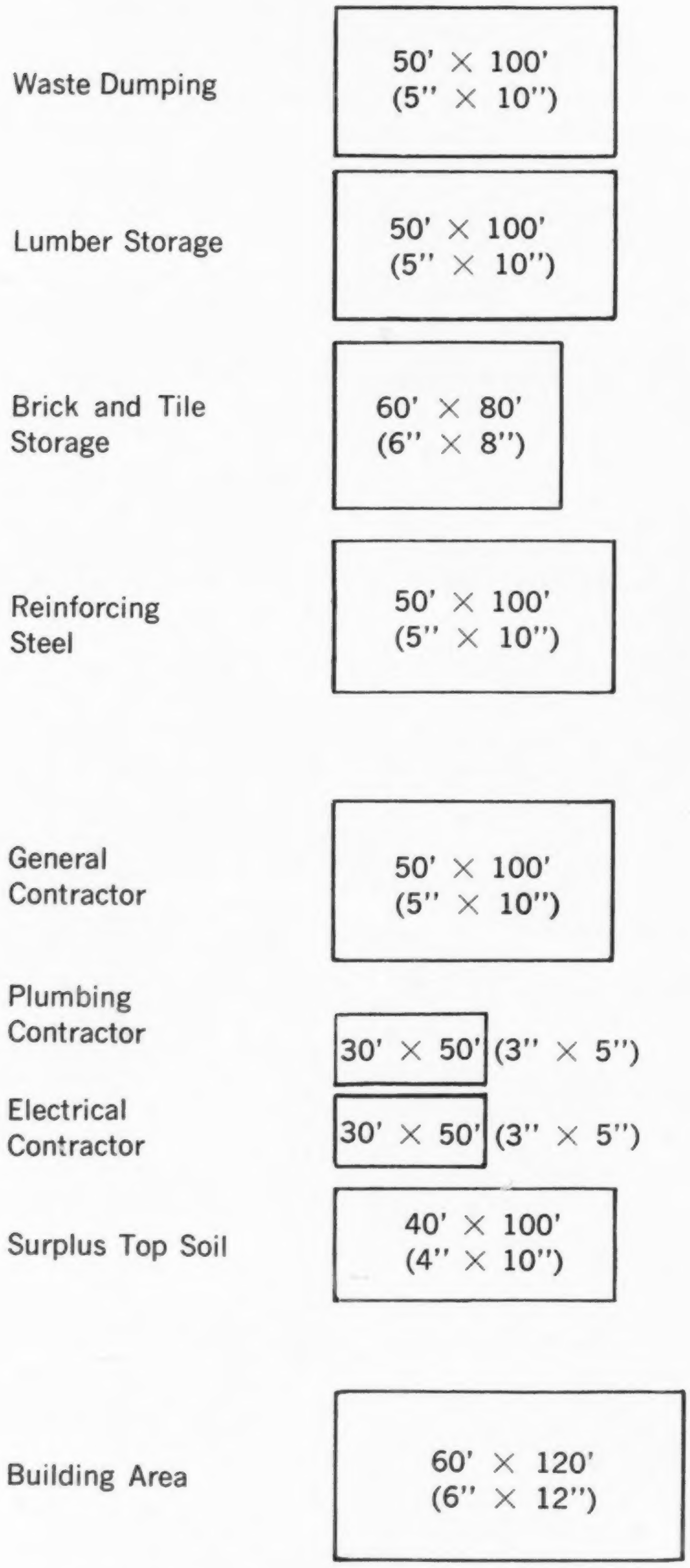

Waste Dumping
50' × 100'
(5" × 10")
Lumber Storage
50' × 100'
(5" × 10")
Brick and Tile Storage
60' × 80'
(6" × 8")
Reinforcing Steel
50' × 100'
(5" × 10")
General Contractor
50' × 100'
(5" × 10")
Plumbing Contractor
30' × 50'
(3" × 5")
Electrical Contractor
30' × 50'
(3" × 5")
Surplus Top Soil
40' × 100'
(4" × 10")
Building Area
60' × 120'
(6" × 12")

Fig. 30-11. Temporary Facilities and Areas

site in the places where they will be most efficient when construction begins. Figure 30-12 will give you an idea of where to locate the temporary facilities.

5. When you have what you think is an efficient arrangement, have your teacher check your site.
6. After the site is approved, remove all cutouts, string, and nails.

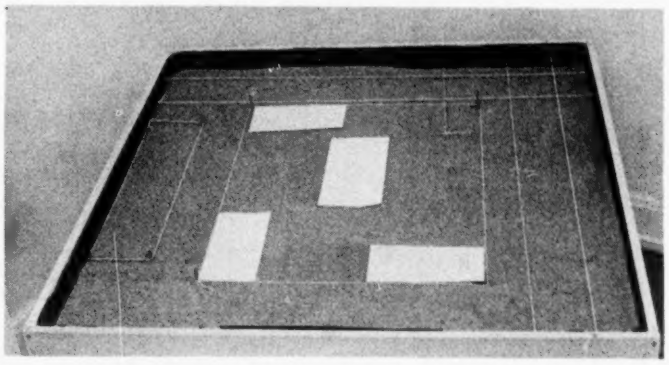


Fig. 30-12. Example Arrangement of Temporary Facilities

**ACTIVITY 31A**

# Clearing the Site

Today you will inspect a model site and decide what processes and equipment are to be used to clear some obstacles.

**Problem**

## Objective:

Given some obstacles which will be in the way of a proposed construction project, identify the practice and equipment to be used to clear the site.

**Equipment** (Group of 5)

1 site box with obstacles, as follows:
- shrubs
- trees
- fence
- stones and rocks
- tree branch and tree stumps
- aluminum foil, representing a pond
- paper towel roll
- cardboard boxes for barn and storage buildings

## Identifying Obstacles

1. Study the existing site as shown in the site box. See Fig. 31A-1.
2. Study Fig. 31A-2, a proposed construction project.
3. In Fig. 31A-3 check those objects that you think will be in the way of construction or will not look good. You can check more than one reason or practice.

## Selecting Practices

4. On Fig. 31A-3 check only those sections that apply to the obstacles you have checked. Check the "Reason," "Practice," and "Equipment" that apply to the solution of your problem. For example, No. 11 (tree stumps) has been answered. The teacher will go over this with you.

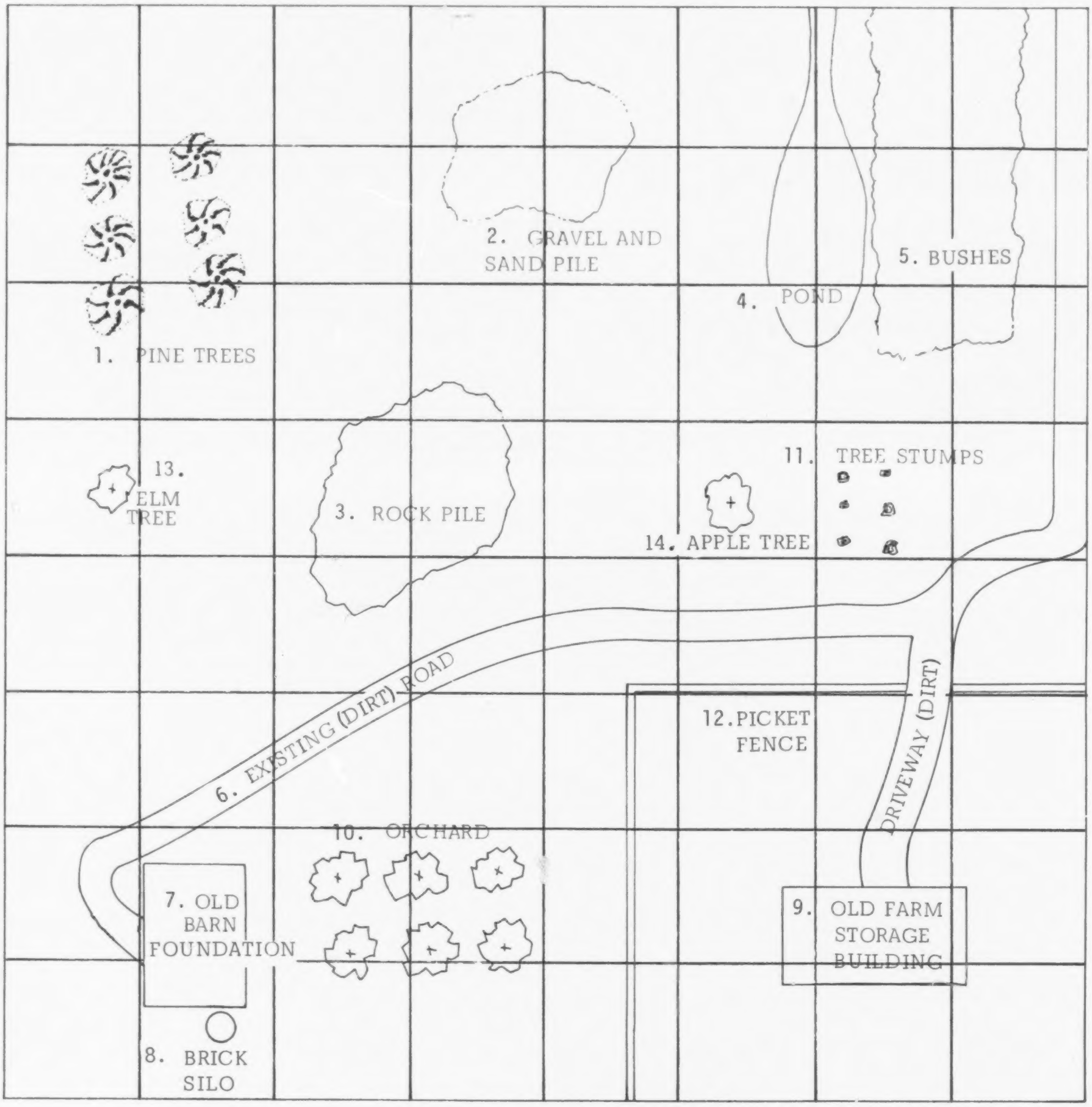

1. PINE TREES
2. GRAVEL AND SAND PILE
3. ROCK PILE
4. POND
5. BUSHES
6. EXISTING (DIRT) ROAD
7. OLD BARN FOUNDATION
8. BRICK SILO
9. OLD FARM STORAGE BUILDING
10. ORCHARD
11. TREE STUMPS
12. PICKET FENCE
13. ELM TREE
14. APPLE TREE
DRIVEWAY (DIRT)

Fig. 31A-1. Existing Construction Site

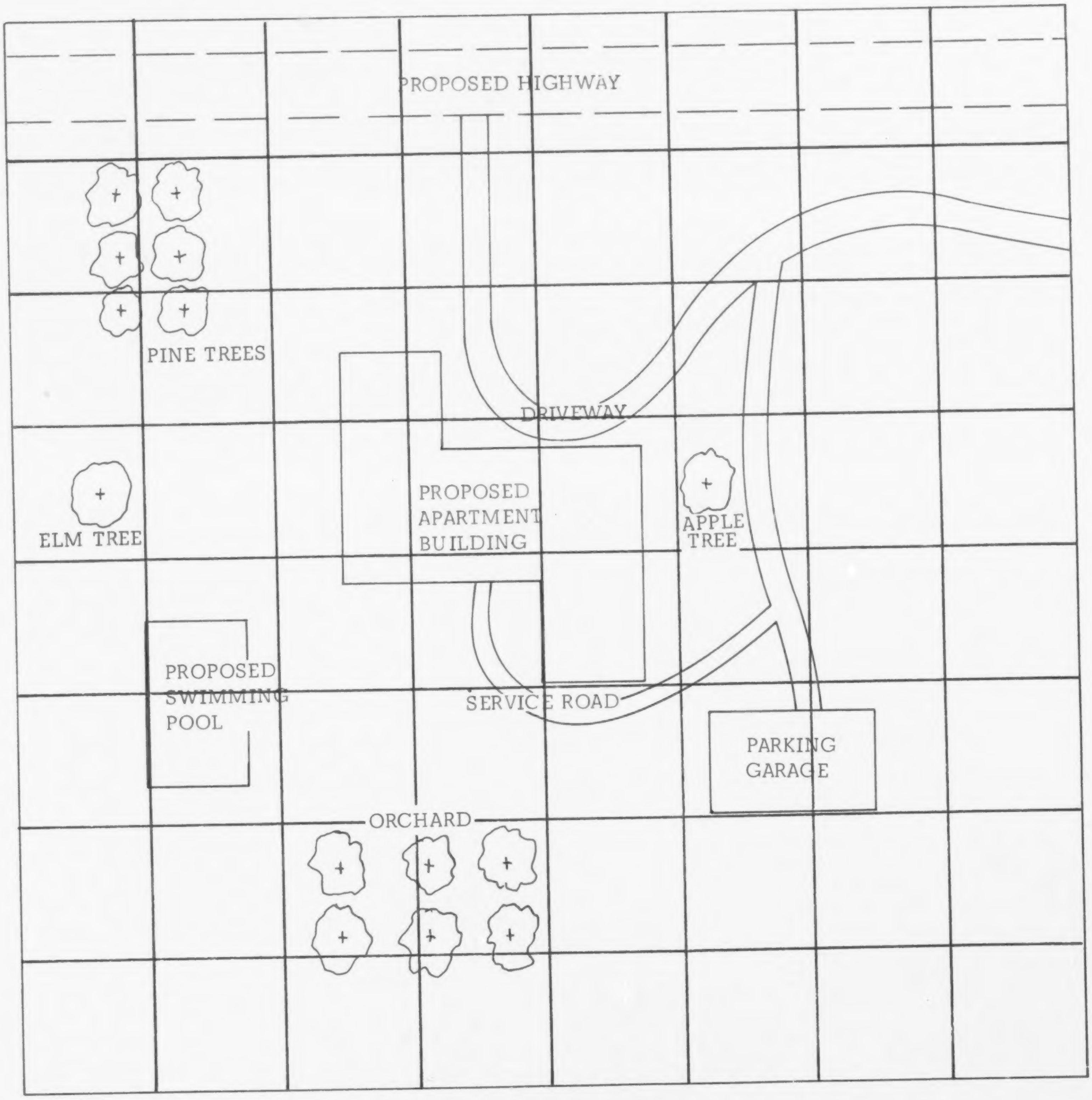

PROPOSED HIGHWAY
PINE TREES
DRIVEWAY
ELM TREE
PROPOSED APARTMENT BUILDING
APPLE TREE
PROPOSED SWIMMING POOL
SERVICE ROAD
PARKING GARAGE
ORCHARD

Fig. 31A-2. Proposed Construction Project

| Obstacle Found onon the Site | Reason for Clearing | | Practice | | | | | | Equipment | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In Way of Planned Construction | Unsightly | Demolishing | Salvaging | Cutting | Burning | Earthmoving | Disposing | Axes | Saws | Crowbars | Crane with Wrecking Ball | Crawler Tractor with Bulldozer Blade | 2 Crawler Tractors with Chains | Matches | Explosives | Dump Truck | Crawler Tractor with Bucket | Sump Pump |
| 1. Pine trees | | | | | | | | | | | | | | | | | | | |
| 2. Gravel and sand pile | | | | | | | | | | | | | | | | | | | |
| 3. Rock pile | | | | | | | | | | | | | | | | | | | |
| 4. Pond | | | | | | | | | | | | | | | | | | | |
| 5. Bushes | | | | | | | | | | | | | | | | | | | |
| 6. Existing dirt road | | | | | | | | | | | | | | | | | | | |
| 7. Foundation of old barn | | | | | | | | | | | | | | | | | | | |
| 8. Brick silos | | | | | | | | | | | | | | | | | | | |
| 9. Old farm storage building | | | | | | | | | | | | | | | | | | | |
| 10. Orchard | | | | | | | | | | | | | | | | | | | |
| 11. Tree stumps | | X | | | | | | X | | | | | X | | X | | X | X | |
| 12. Fence | | | | | | | | | | | | | | | | | | | |
| 13. Elm tree | | | | | | | | | | | | | | | | | | | |
| 14. Apple tree | | | | | | | | | | | | | | | | | | | |

Fig. 31A-3. Site Clearing Chart

**ACTIVITY 31B**

# Clearing the Site

Today you will work with your group planning how to clear a site.

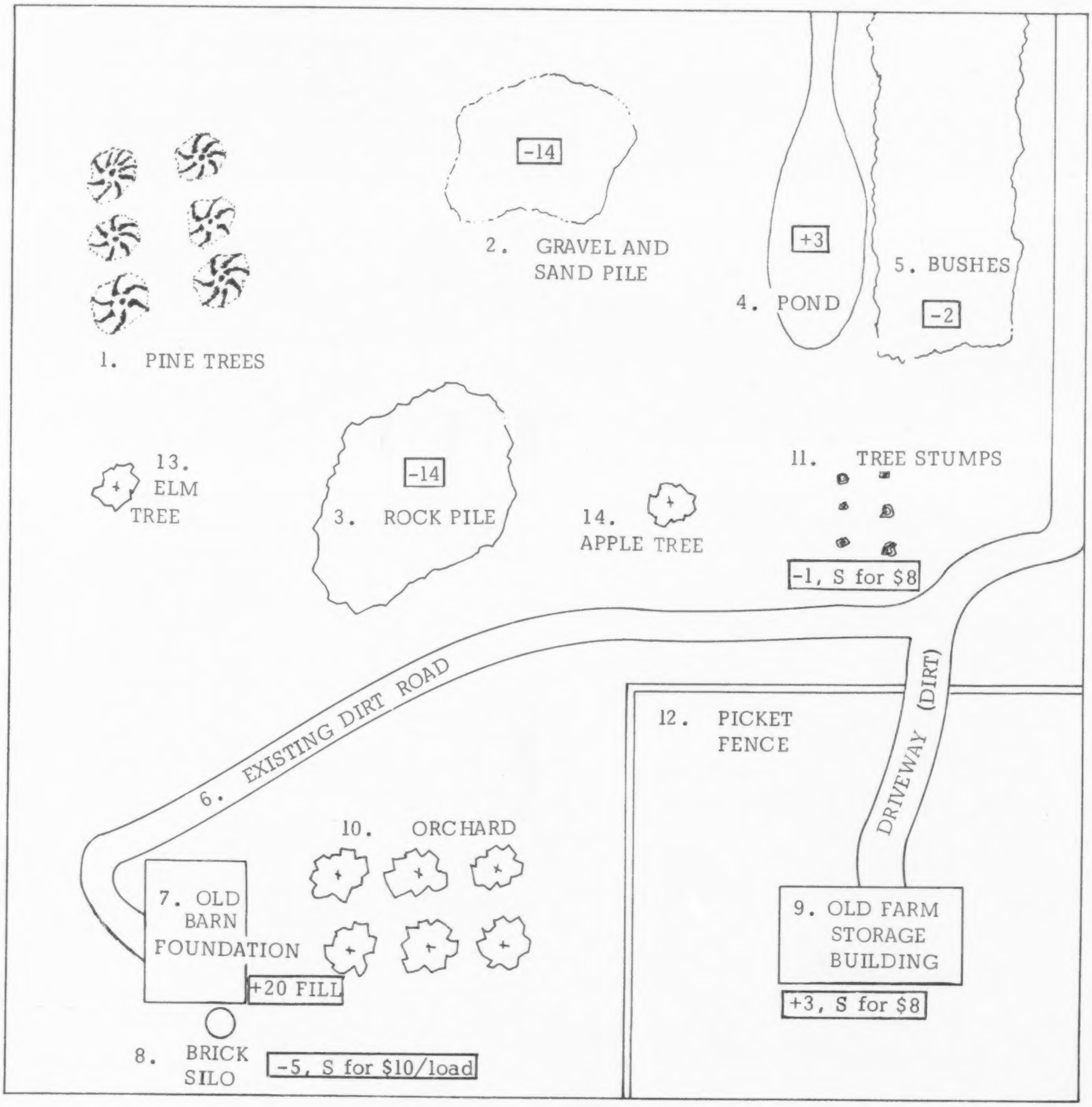
## Problem

### Objective:

Given an illustration of an apartment building site and an efficiency chart which specifies costs, determine the most efficient technique for disposing of site obstacles and determine the cost of clearing.

### Determining Efficiency

1. Study Fig. 31B-1. It shows the area to be cleared for an apartment building. Some of the obstacles must be disposed of before construction can begin.
2. Determine what you can do with each obstacle listed in Fig. 31B-2.
3. For example, if you move three truckloads of fill from the pile of gravel and sand (obstacle number 2) to fill in the pond (obstacle number 4), it will cost you $10 per trip or $30. You still have 11 truckloads of sand and gravel to dispose of. Keep a count of what is filled in and where on Fig. 31B-1.
4. Check how you will dispose of each obstacle and the cost in Fig. 31B-2. If you burn anything, you must pay $2 for each burning permit.
5. Every time you move anything it will cost you $10 for equipment rental. It even costs you $10 to take an $8 load of tree stumps to the city. See the example in Fig. 31B-2. Note in the example that the best choice is to sell the tree stumps for $8 even though it cost $10 to haul them away. This costs the contractor only $2 net (the difference between cost and sales). If the choice had been to bury the stumps, it would still cost $10 to truck them to a place where fill is needed; and you already have a surplus of better fill materials. If the stumps were burned, a burn permit would cost $2 only you would still have an ash pile to spread, requiring a $10 equipment rental. Thus the total cost of burning would be $12.



-14
2. GRAVEL AND SAND PILE
+3
4. POND
5. BUSHES
-2
1. PINE TREES
13. ELM TREE
-14
3. ROCK PILE
14. APPLE TREE
11. TREE STUMPS
-1, S for $8
6. EXISTING DIRT ROAD
DRIVEWAY (DIRT)
12. PICKET FENCE
10. ORCHARD
7. OLD BARN FOUNDATION
+20 FILL
9. OLD FARM STORAGE BUILDING
+3, S for $8
8. BRICK SILO
-5, S for $10/load

Legend:
- - Haul Away or Stockpile
- + Filling
- S Salvage
- 14 No. of Truck Loads

Examples:

+3 means that 3 truck loads of fill must be added

-5, S for $10/load means that 5 truck loads of material can be salvaged at $10 per load

Fig. 31B-1. Apartment Building Site

| Site Reference Number | Disposing |  |  |  |  | Others |  |  | Loads |  |  | Cost |  | Sales |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Stockpiling | Burying | Burning | Spreading | Hauling Away | Salvaging | Hauling in fill dirt | Dozing in fill | Truckloads | Truckloads hauled away | No. where excess was used | Equipment rental $10 per vehicle trip | Burning permit $2.00 | Sales per load | Total sales |
| 2. Gravel and sand pile: about 14 truckloads of fill have been piled here. |  | ■ | ■ |  |  | ■ |  |  | -<br>14 |  |  |  | ■ | ■ | ■ |
| 3. Rock pile: there are about 14 truckloads piled here. |  |  | ■ |  |  | ■ | ■ |  | -<br>14 |  |  |  | ■ | ■ | ■ |
| 4. Pond: this low spot will need 3 loads of fill (any material) to fill it in. | ■ | ■ | ■ |  |  | ■ |  |  | +<br>3 |  |  |  | ■ | ■ | ■ |
| 5. Bushes: there are about 2 truckloads located on dry land near the pond. | ■ |  |  | ■ |  | ■ | ■ | ■ | -<br>2 |  | ■ |  |  | ■ | ■ |
| 7. Old barn and silo foundation: foundations were never filled in. They would require 20 truckloads of fill (any material). |  |  | ■ |  |  |  |  |  | +<br>20 |  |  |  |  | ■ | ■ |
| 8. Silo: 5 truckloads of bricks can be sold for $10 a load. |  |  | ■ |  |  |  | ■ | ■ | -<br>5 |  |  |  | ■ |  |  |
| 9. Old farm storage building: 3 truckloads of lumber can be salvaged and sold in town for $8 a load. |  |  |  | ■ |  |  | ■ | ■ | -<br>3 |  |  |  |  |  |  |
| EXAMPLE<br>10. Tree stumps: these small fruit tree stumps can be hauled away as 1 truckload. Stumps can be sold in town for $8 a load. | ■ |  |  | ■ | X | X | ■ | ■ | -<br>1 | 1 |  | 10 |  | 8 | 8 |

Total $ ______

$+ ______

Total Costs $ ______

Total Sales $- ______ SUBTRACT

Cost of Clearing $ ______

Fig. 31B-2. Site Clearing Efficiency Chart

**ACTIVITY 32**

# Locating the Structure

Once the site has been cleared, the contractor is ready to locate the structure on the building site. Your activity today is locating building lines and control points. You will use the same practices that contractors use on the construction site.

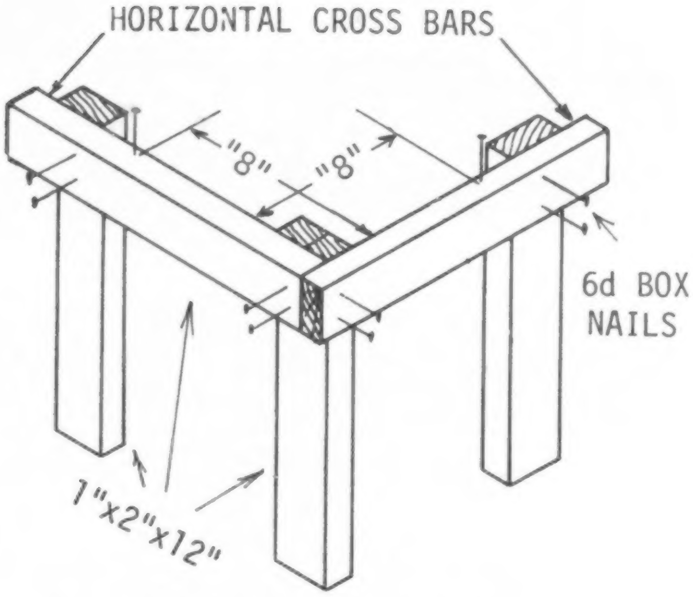

HORIZONTAL CROSS BARS
"8"
"8"
6d BOX NAILS
1"x2"x12"
MAKE 4 SETS OF BATTER BOARDS

Fig. 32-1. Assembling Batter Boards

## Problem 1

### Objective:

Given the equipment and supplies, construct right-angle batter boards.

**Equipment** (Group of 5)

| | |
|---|---|
| 2 | hammers |
| 1 | plumb bob |
| 1 | 12" rule |
| 1 pr. | scissors |

**Supplies** (Group of 5)

| | |
|---|---|
| 1 | site box with sand |
| 74 | 6d box nails |
| 20 pcs. | 1" x 2" x 12" batter boards |
| 1 ball | string |

### Making Batter Boards

1. Assemble batter boards as shown in Fig. 32-1.
2. Nail the batter boards to the site box as shown in Fig. 32-2.
3. Assume the building outline is to be 8" from the inside of the batter boards. Measure and mark the horizontal crossbars for nails as shown in Fig. 32-1.
4. Drive these nails *part of the way* in. There should be room to tie strings to them.

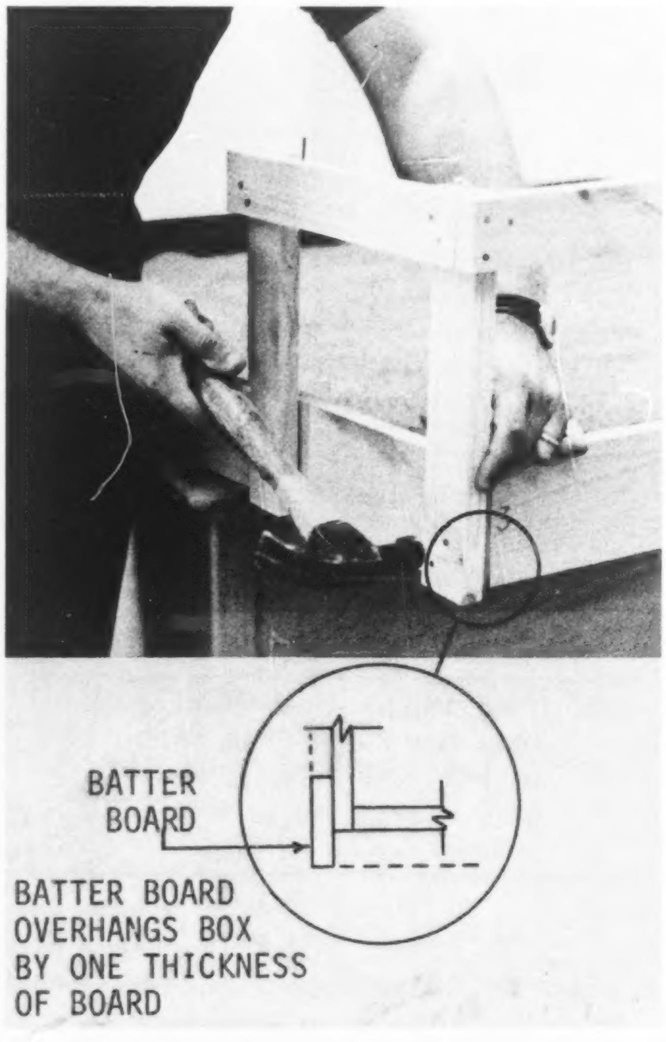

BATTER BOARD
BATTER BOARD OVERHANGS BOX BY ONE THICKNESS OF BOARD

Fig. 32-2. Nailing Batter Boards to Site Box

## Problem 2

### Objective:

Given a site box with batter boards and string, locate the outside walls of a building by running lines to points on the batter boards.

### Locating the Building Lines

1. Run strings from the nails on the batter boards to opposite nails. See Fig. 32-3.

### Checking Lines

2. Check for squareness by measuring the diagonals. See Fig. 32-3. Diagonal A should equal diagonal B.
3. Adjust the nails and strings until diagonals A and B are equal. Have your teacher check your diagonals. The strings mark the location of the outside wall of the proposed building.

## Problem 3

### Objective:

Given a site box with batter board and string, and a plumb bob, locate the four corner ground points.

### Locating the Building Lines

1. Using the plumb bob, find the exact corner ground points. This is done by placing the plumb bob at the intersections of the strings. Slowly lower the plumb bob until it just touches the sand. See Fig. 32-4.
2. Mark the corner with a small stake (6d nail). Do this for all four corners.
3. Take apart all batter boards and remove all nails. Wind up the string. Replace all equipment and supplies.

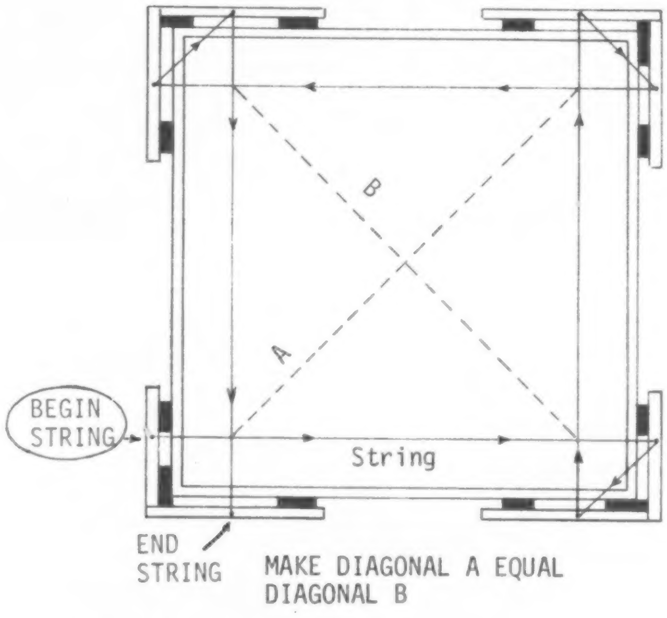


Fig. 32-3. Batter Board and String Location

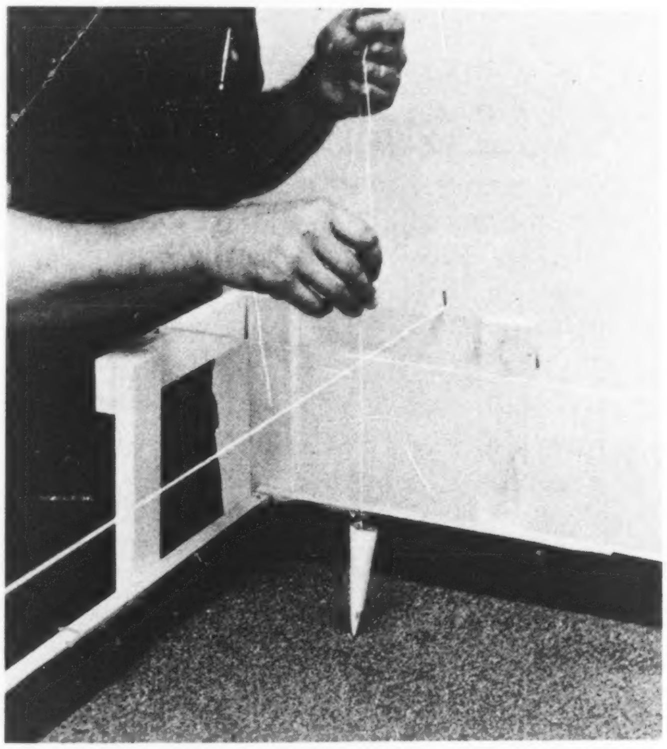


Fig. 32-4. Locating Ground Points

**ACTIVITY 33A**

# Earthmoving

## Problem

### Objective:

Given an earthmoving problem of filling a 100 cubic yard hole with compacted soil and a truck that can carry 10 cubic yards of soil, figure how many truckloads of soil are needed to fill the hole with compacted soil.

### Earthmoving Situation

1. You are a contractor for a highway construction job. The highway is being constructed across a farmer's property. One of the old farm buildings has been cleared, but there is a 100 cubic yard hole left by the foundation. This hole is directly in the path of the highway. See Fig. 33A-1. The hole must be filled with soil and compacted to prevent the future highway from cracking.
2. Figure how many truckloads of natural soil must be moved and compacted to fill the hole.

### Reviewing Soil Factors

3. As you recall from soil testing (Activity 9A and B), earth in its natural state will take up more space when it is excavated (dug up). Earth in its natural state also can be compacted. See Fig. 33A-2, Soil Characteristics.

### Cubic Feet and Yards

4. Any material 12″ thick x 12″ deep x 12″ high is called a cubic foot. The shape forms a cube of material. See "A" in Fig. 33A-3. It would take 27 of these cubes to make a larger cube 3′ x 3′ x 3′. See "B" in Fig. 33A-3.

### The Earthmoving Problem

5. The size hole you need to fill is 100 cubic yards.

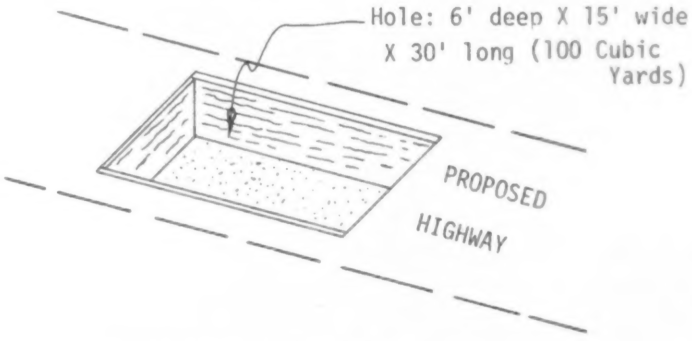

Hole: 6' deep X 15' wide X 30' long (100 Cubic Yards)
PROPOSED
HIGHWAY

Fig. 33A-1. Highway Construction Site

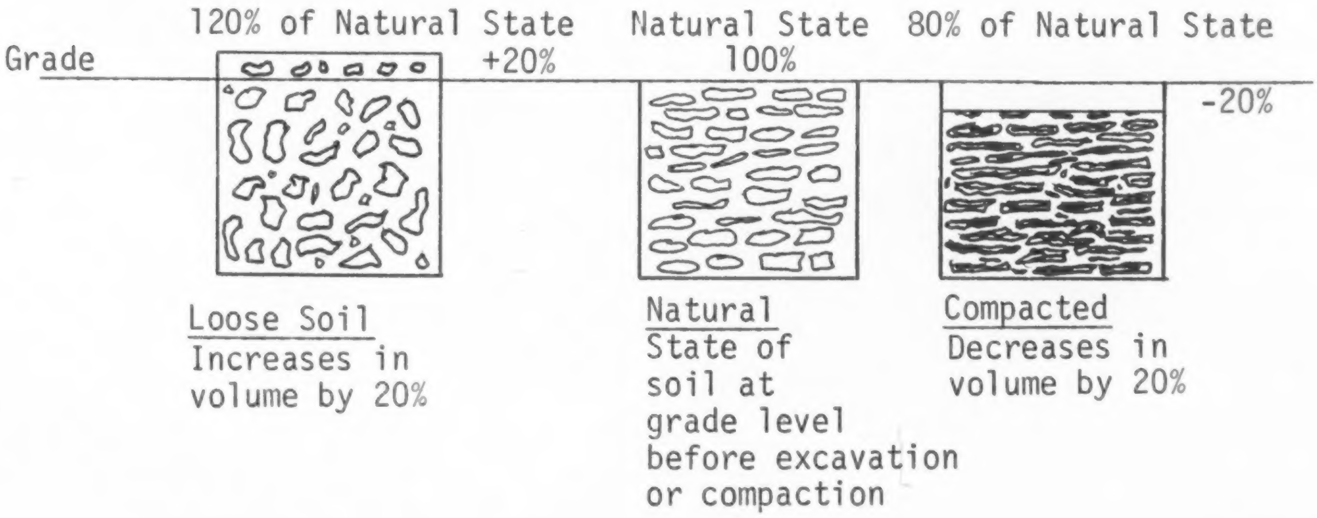

120% of Natural State
Natural State
80% of Natural State
Grade
+20%
100%
-20%
Loose Soil
Increases in volume by 20%
Natural
State of soil at grade level before excavation or compaction
Compacted
Decreases in volume by 20%

Fig. 33A-2. Soil Characteristics

6. The truck you will use can carry 10 cubic yards of soil at a time.
7. How many truckloads are needed to fill a 100 cubic yard hole with compacted soil?

______________________

8. Review the Earthmoving Factors in Fig. 33A-4.

## Solving the Problem

9. Find how much the natural soil will increase when it is excavated.

   The amount of compacted fill is 100%

   The amount of natural soil is 100 cubic yards + 20% *or*

   100 × 1.20 = ____ cubic yards of exexcavated soil

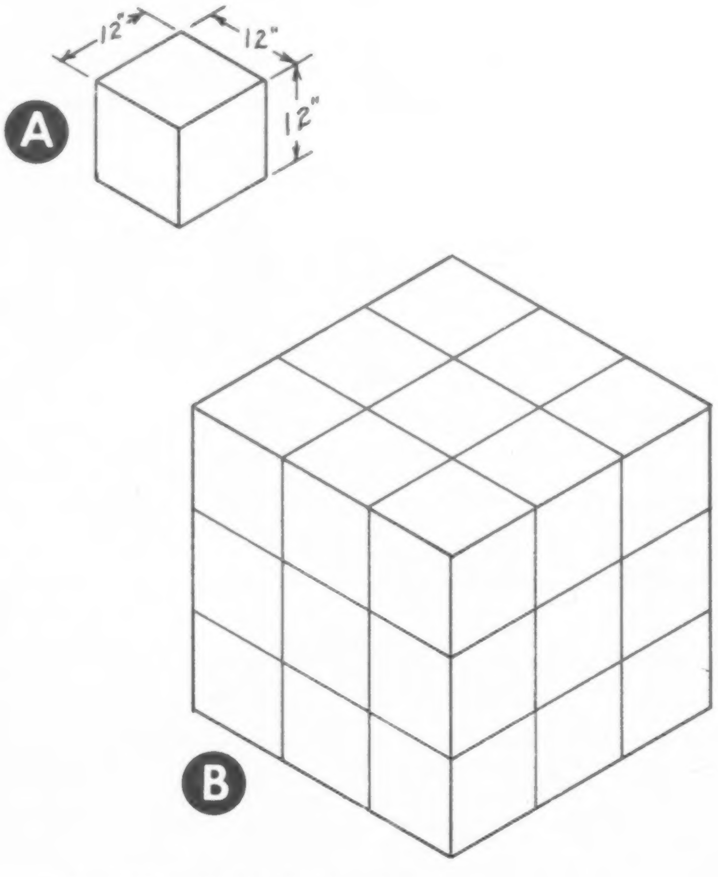


Fig. 33A-3. Cubic Feet and Yards
A. Cubic Foot
B. Cubic Yard

10. Now find how many truckloads are needed to fill the 100 cubic yard hole with compacted soil.

    truckloads = (excavated soil + 20%)
    *or*

$$\frac{\text{cubic yards of excavated soil} \times 1.20}{\text{10 cubic yards (amount in 1 truckload)}} =$$

    ____ truckloads

11. As a class, discuss why knowing how to solve these problems is important knowledge for an earthmoving contractor.

Fig. 33A-4. Earthmoving Factors

| **Soil Condition** | **%** |
|---|---|
| Natural Soil | 100% |
| Loose Soil (excavated) | 120% |
| Compacted Soil | 80% (of natural soil) |
| **Cubic Yards** | |
| 1 Truckload | = 10 cubic yards |
| Hole to be Filled | = 100 cubic yards |
| **Problem** | |
| How many truckloads are needed to fill a 100 cubic yard hole with compacted soil? ______________________ | |

**ACTIVITY 33B**

# Earthmoving

Today you will try solving some of the problems of a contractor. He has contracted an earthmoving job of leveling a 100 acre cow pasture for a highway site. He must estimate some costs.

## Problem

**Objective:**

Given an efficiency chart, equipment costs, and a graph to determine acres of earth moved per hour,

a. Figure the amount of earth moved per hour.
b. Select the proper earthmoving equipment.
c. Figure the equipment costs.

**Equipment** (Each student)
1 12″ rule

Fig. 33B-1. Efficiency Chart

| | | I | II | III | IV | V | VI | VII |
|---|---|---|---|---|---|---|---|---|
| Equipment | Problem | Width of Cut, in Feet | Speed, in Miles Per Hour | Area, in Acres Per Hour | Number of Hours | Equipment Cost/Hr | Total Cost | Most Efficient |
| Bulldozer: Minor leveling and excavation | 1 | 4 | 7 Example | 2.8 | 39 | $20.00 | $780 | |
| | 2 | 6 | 6 | | | | | |
| | 3 | 7 | 3 | | | | | |
| | 4 | 8 | 5 | | | | | |
| | 5 | 9 | 4 | | | | | |
| Scraper: Major leveling and excavation | 1 | 3 | 7 | | | | | |
| | 2 | 4 | 6 | | | | | |
| | 3 | 5 | 4 | | | | | |
| | 4 | 6 | 5 | | | | | |
| | 5 | 7 | 3 | | | | | |
| Truck: Excess earth transported from site | | | | | | | | |
| Front-end loader: Loading of excess dirt into trucks | | | | | | | | |
| | | | | | | | Total Equipment Cost | |

## Reviewing the Problem

1. To level the cow pasture for the highway site you are going to use a scraper for major leveling and a bulldozer for minor leveling. You will use a loader and a truck to load and carry away excess soil.
2. What you do not know is what size scraper or what size bulldozer to use. You need to find out what size equipment will be the most efficient (move the most earth for the least cost). For this problem you will only figure the cost for one cut or pass over the 100 acre cow pasture.

## Determining Acres Moved Per Hour

3. Study Fig. 33B-1, Efficiency Chart. Look at Columns I, II, III. Column I gives the width of the blade cut in feet. Column II gives the speed of the equipment in miles per hour for each blade size. You need to determine the acres of land moved per hour for each size blade (Column III). If you do not know what a bulldozer or scraper looks like see Fig. 33B-2.
4. Study Fig. 33B-3. Notice Column A (Speed in miles per hour), Column B (Area in acres per hour), and Column C (Width of cut in feet).
5. For each problem, (from Fig. 33B-1, Problem Column), find the bulldozer width of cut in feet (column I) and speed in miles per hour (column II). Now locate the width of cut and speed in Fig. 33B-3. This is Column C and Column A. Using a rule, draw a straight line between these two points and read the area in acres per hour where the line crossed Column B.
6. Record the area in acres per hour in Column III, Fig. 33B-1.
7. Repeat steps 5 and 6 to find the acres of earth moved by the scraper.
8. Read Fig. 33B-4, Hours, to find the number of hours each piece of equipment is needed. Enter the number of hours in Column IV of Fig. 33B-1.

## Determining Costs

9. Look in Fig. 33B-2 Equipment Costs to find the cost per hour for the bulldozer and scraper. Enter this figure in Column V, Fig. 33B-1.
10. In Fig. 33B-1, multiply the Number of Hours (IV) by the Equipment Cost (V) to find the total cost (VI). Enter this figure in Column VI. Do this for both pieces of equipment.
11. Record the lowest cost figure of the bulldozer and scraper in Column VII. This figure represents the most efficient way to move the earth.

## Determining Truck and Loader Costs

12. It is necessary to have a truck and front end loader on the job to load and carry away the excess soil. Therefore, both the truck and loader must be on the site the same number of hours as the bulldozer and scraper.
13. In Fig. 33B-1, Column IV, find the number of hours the most efficient bulldozer and scraper are needed. Record the highest of these two figures in Truck, Column IV, and Front End Loader, Column IV.
14. Look at Fig. 33B-2 to find the equipment cost for the truck and loader. Enter these costs in Column V.
15. Multiply the Number of Hours (IV) by the Equipment Cost (V) to find the total cost (VI). Record these figures again in Column VII.
16. Add all of the figures in Column VII to find the total Equipment Cost.

Fig. 33B-4. Hours

| Area in Acres Per Hour | Number of Hours Needed |
|---|---|
| 2.0 | 50 |
| 2.1 | 48 |
| 2.4 | 42 |
| 2.8 | 39 |
| 3.0 | 33 |
| 3.6 | 28 |
| 4.0 | 25 |

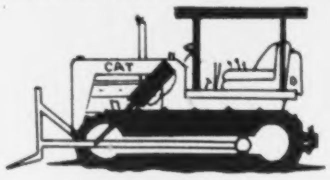
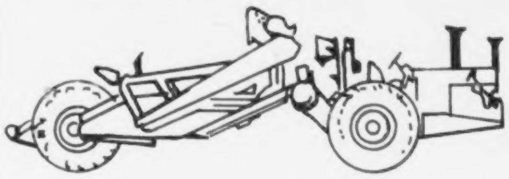
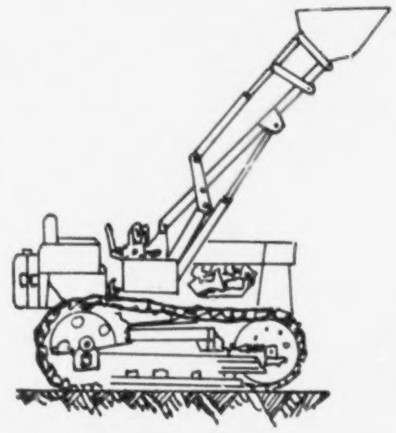
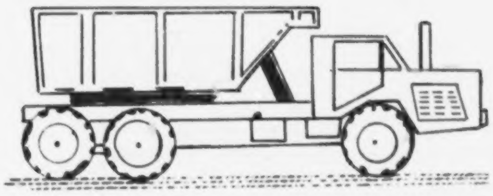
| | Main Uses | Cost Per Hour |
|---|---|---|
| Tractor with Dozer Blade<br> | Shallow digging<br>Digging to depth<br>Short haul scraper operations<br>Transferring | $20.00 |
| Scraper Pan<br> | Leveling operation<br>Excavation | $30.00 |
| Front End Loader<br> | Shallow digging<br>Digging to depth<br>Short haul scraper operations<br>Loading trucks | $15.00 |
| Dump Truck<br> | Transferring material from excavation site to disposal site | $10.00 |

Fig. 33B-2. Equipment Costs

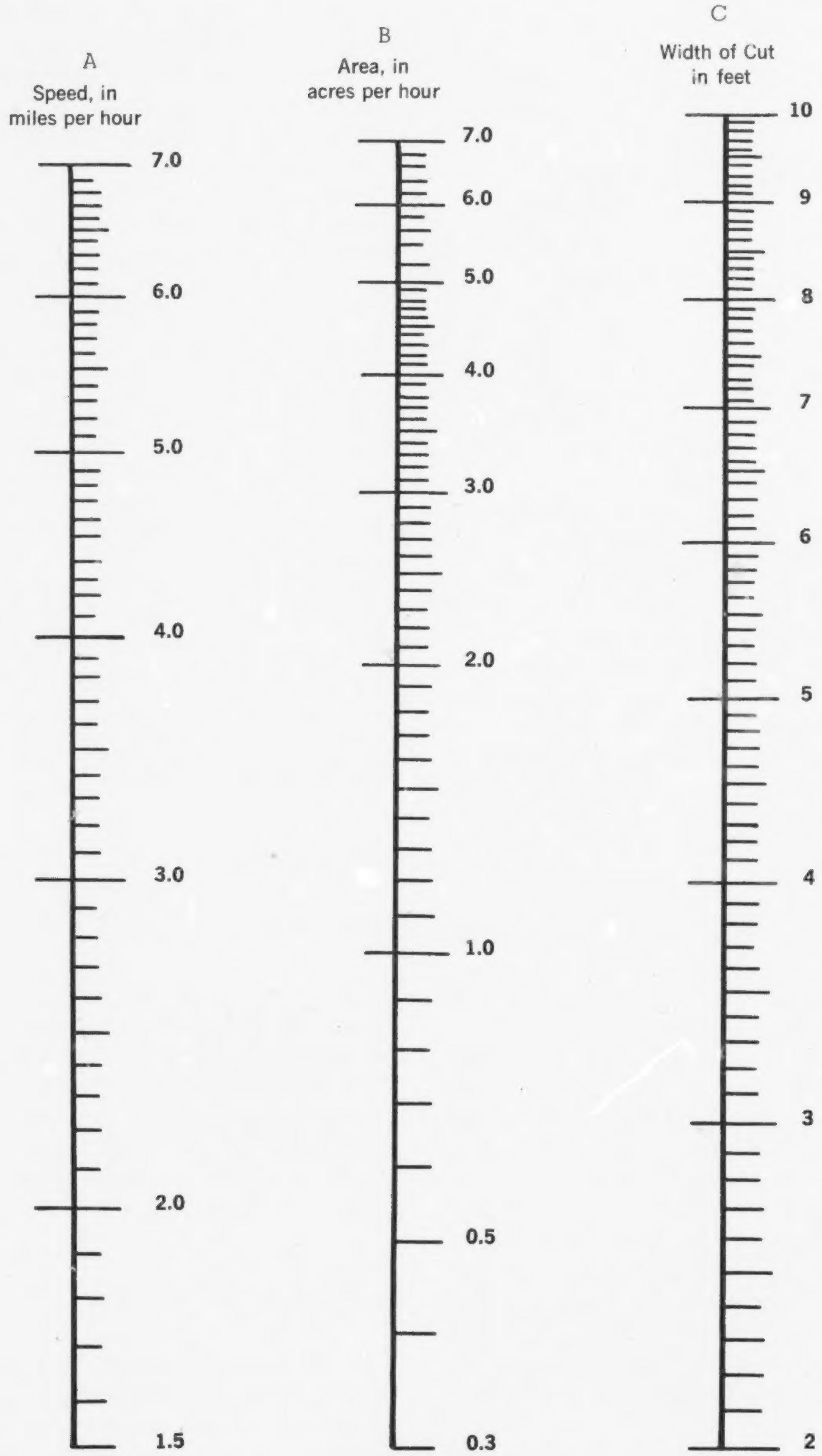


Fig. 33B-3. Graph I

## ACTIVITY 34A

# Handling Grievances

## Problem 1

### Objective:

Given a role-playing situation concerning a labor-management grievance,

a. Serve as a labor representative to a grievance committee and present the position for a satisfactory solution from the worker's viewpoint, *or* serve as a management representative to a grievance committee and present the position for a satisfactory solution from management's viewpoint.
b. Participate in a simulated collective bargaining session to work out a solution to a grievance.

### Selecting Roles

1. Your teacher will direct you to become either a representative of labor or management.
2. Assemble with your committee and read the "Grievance" and the "Dispute."

### The Grievance

A new state highway is being constructed near your city. The state has contracted a 100 mile section of the highway to J. M. Beck Construction Company. As is typical with highway jobs, J. M. Beck Construction Company has hired construction workers from the city nearest to the highway site. Most of the workers come from your city which is near the start of the highway. The workers do excellent work and know their jobs well.

As work on the highway progresses, the construction site moves farther and farther away from where the workers live. J. M. Beck moves its field office trailer as the work progresses. The workers, however, have further and further to drive to work. The workers are getting upset because it is costing them more to drive to work, and it is taking longer to get to work every day. The workers have to get up earlier and they get home later as the work progresses. Morale has dropped and accidents are increasing.

J. M. Beck Construction Company is upset because workers are arriving late and work is getting behind schedule. Beck is also complaining that the workers seem to be tired before quitting time. The accident rate is increasing because workers are not as alert to dangerous situations. This also slows down work and increases accident insurance rates.

If the highway is not completed on schedule, J. M. Beck Construction Company will lose money. There are still 40 miles of highway to construct. Trying to employ new workers and break them in is out of the question at this point if the construction deadline is to be met.

### The Dispute

#### Labor Position

The workers are demanding more money to pay for their increased travel costs. They are spending about 3 hours a day in travel. They are demanding a 1 hour shorter work day to increase morale and cut down on accidents and to get them home before dark. There is talk of a strike if an agreement cannot be reached.

#### Management Position

J. M. Beck Construction Company says there is nothing in the collective bargaining agreement which talks about payment to workers for transportation to and from the construction site.

**Note**

The collective bargaining agreement does not say, however, this cannot be done. Therefore, the grievance process can be used to settle this dispute.

Beck's construction budget does not allow for extra pay except overtime, and the workers won't work overtime. They want off earlier! Beck has to pay rental costs on the equipment if it is in operation or standing idle. Beck says the workers should have known that the construction site would be moving. Beck feels the workers don't care if the company meets the deadline or not, nor if the company loses money on the job. The company's reputation as a highway builder may be at stake. The company feels the workers should be grateful they have a good job.

## Handling Grievances

3. You have been selected as a committee member to represent one group's position in trying to arrive at a solution to the grievance.
4. Discuss the grievance and try to reach a solution that is acceptable to both groups.

**ACTIVITY 34B**

# Handling Grievances

## Problem

### Objective:

Given a grievance problem:

a. Serve as a labor or management member of a grievance committee and present a position for a satisfactory solution of the problem.
b. Participate in a collective bargaining session.

### Labor's Position

The workers at one of the Ajax road building sites claim that not enough safety measures are being taken to protect the workers. They suggest that the company take more safety measures. Here are some of the attitudes and problems of the workers.

1. The site is not safe.
   a. The men are working on a major highway which is not closed to traffic.
   b. The men must work when there is rush-hour traffic.
2. Working conditions are inconvenient to workers.
   a. Because the highway is not closed, workers must park cars a long distance from the site. Therefore, it takes workers 20 minutes to walk to the job.
   b. Workers cannot perform their work efficiently because of the heavy rush-hour traffic.
3. Traffic patterns are not safe.
   a. Traffic should be rerouted so that work can be performed safely.
   b. Work should not be performed during rush-hour traffic.

### Management's Position

Here are the attitudes and problems of the employer.

1. The site is safe.
   a. More workers than usual have been hired to serve as flagmen.
   b. Barricades have been set up to protect the workers.
   c. Workers have been issued red safety jackets.
2. Working conditions are not inconvenient to workers.
   a. Parking sites have been arranged so workers do not have to walk for more than 5 minutes.
   b. Most construction operations can be performed unhindered by traffic.
3. Traffic patterns cannot be changed.
   a. The contract calls for work to be performed without any stoppage of traffic flow.
   b. Rerouting traffic would be an inconvenience to the general public.

### Solving the Problem

You are to act out the parts of (1) officers of the local union or (2) members of the general office of the company. Remember that the attitudes of management or labor must be your attitudes while you are playing a role. Go into the grievance procedure meeting and see if you can find a solution to the problem that is agreeable to both sides.

**ACTIVITY 35**

# Stabilizing Earth and Structures

Today you will excavate a site and underpin two model buildings.

**Problem**

### Objective:

Given a site box filled with 2″ of moist sand, two concrete blocks, and wood underpinnings:

a. Underpin a model structure during the excavation of a nearby area.
b. Indicate the techniques of trimming and stabilizing that should be done during the excavation.

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | 2′ spirit level |
| 1 | container of water |
| 2 | spoons for excavating |

**Supplies** (Group of 5)

| | |
|---|---|
| 1 | site box with 2″ moist sand |
| 2 | concrete blocks, 8″ x 8″ x 16″ |
| 8 | $\frac{3}{4}$″ x $1\frac{3}{4}$″ x 2″ wood blocks |

### Assigning Tasks

1. In the preparation, excavation, and underpinning operations, there will be several tasks. The foreman of your group is to assign them to members of his labor gang.

### Preparing the Site

2. If the sand has not been prepared beforehand, add enough water so that it

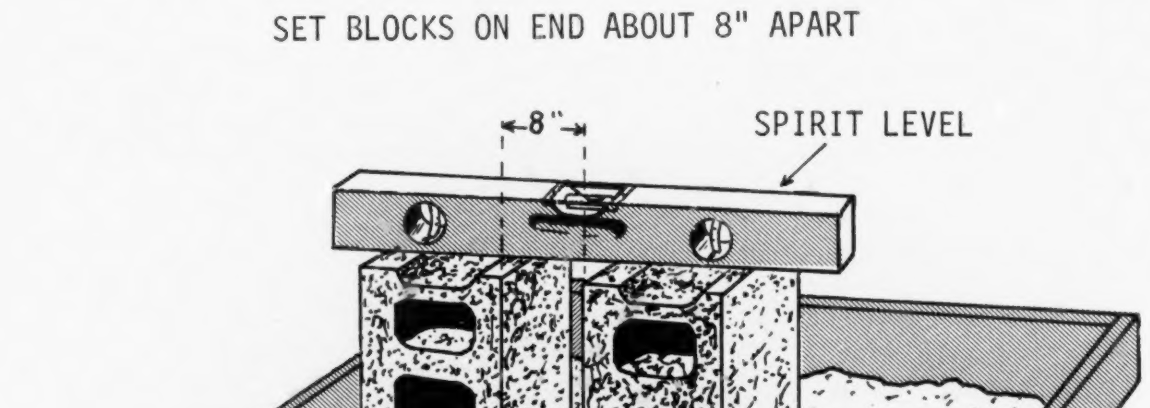


Fig. 35-1. Preparing for Excavation

will support a load. Your teacher will supervise this task.

3. Two members of the group should level and compact the sand, by tamping, to form a firm base. The compacted sand should be 2″ deep.
4. Carefully place two concrete blocks 8″ apart on end (in an upright position) on the packed sand. These blocks will represent two buildings. See Fig. 35-1.
5. Place the spirit level on top of the blocks and adjust the blocks until they are level.

## Excavating

6. Using spoons, excavate the sand from the area between the two blocks until the bottom of the site box can plainly be seen. The bottom of the site box will represent the bedrock, a solid base. See Fig. 35-1. You are to excavate the total area between the blocks. You must *avoid cave-ins or settling* of the structures (blocks).

## Underpinning

7. If necessary, remove enough sand from under both concrete blocks so that underpinning blocks can be put in place. Recall the transparency on underpinning. See Fig. 35-1.
8. Regularly check the level to see if the concrete blocks have moved. (We don't want the building or the walls of the excavation to collapse!)
9. If necessary, put facing or shoring in the excavation.
10. Remove the rest of the sand from between the concrete blocks, putting in underpinning as you work.
11. Make a final check of the level to see if the structures have moved.

## Cleaning Up

12. Return equipment and supplies, and clean the work area.

## Questions

1. What practices did you use to stabilize the excavation?

______________________________

______________________________

2. What practices did you use to stabilize the structures?

______________________________

______________________________

3. Did your structure remain stable and level?

______________________________

**ACTIVITY 36**

# Classifying Structures

Today you will sketch a structure of your own choice.

## Problem

### Objective:

Given some suggestions about building structures:

a. Select and sketch a structure.
b. Identify the substructure and superstructure.
c. Determine the construction processes you need to build your structure.

**Supplies** (Each Student)
2 shts. 8½" x 11" paper
1 pencil/eraser

### Identifying Structural Parts

1. Select and sketch one of the following structures:
   a. Highway
   b. Tower
   c. Dam
   d. Skyscraper
   e. Bridge
   f. Tunnel
   g. Utility
2. Include and identify in your sketch the substructures and superstructures. Draw a cutaway view (section) of the substructure. See Fig. 36-1.

### Identifying Construction Processes

3. Check which steps in the construction process you think apply to the project you are sketching if the structure would be built.

**The Construction Process**

_____ a. Beginning the Project
_____ b. Selecting the Site
_____ c. Buying Real Estate
_____ d. Surveying and Mapping
_____ e. Soil Testing
_____ f. Designing and Engineering
_____ g. Making Working Drawings
_____ h. Writing Specifications
_____ i. Selecting a Builder
_____ j. Contracting
_____ k. Estimating and Bidding
_____ l. Scheduling
_____ m. Hiring Construction Personnel
_____ n. Getting Ready to Build
_____ o. Clearing the Site
_____ p. Locating the Structure
_____ q. Earthmoving
_____ r. Stabilizing Earth and Structure
_____ s. Building the Structure

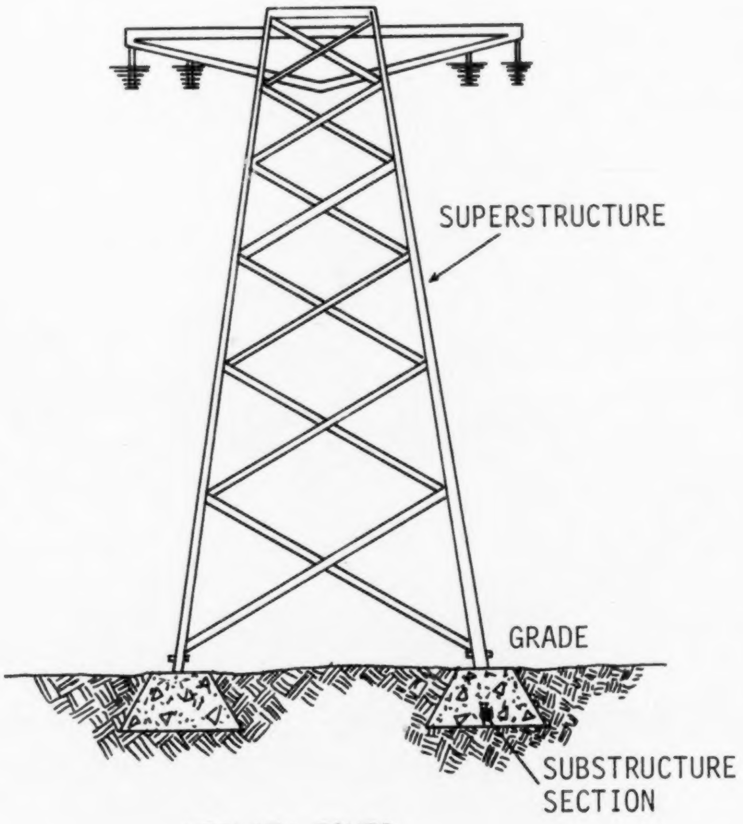


Fig. 36-1. Example Structure

**ACTIVITY 37**

# Setting Foundations

Today you watched a demonstration on the use of pile cap foundations. Now you are going to find out what effect a footing has upon a structure. This will be a group activity.

**Problem 1**

## Objective:

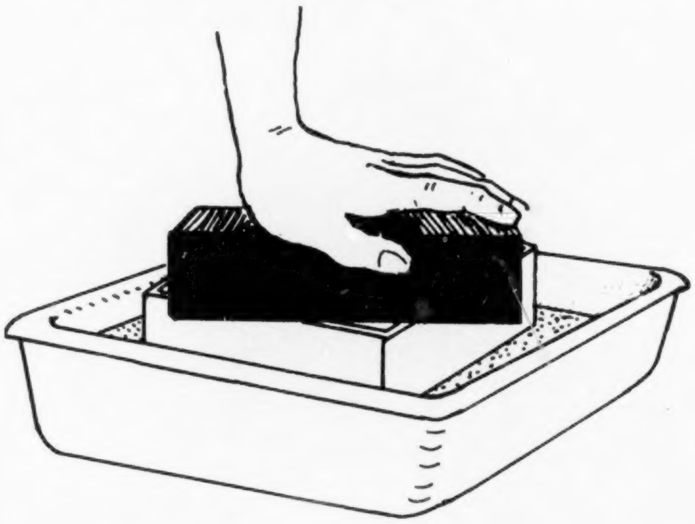
Given a model substructure and load, find out what happens when a load is applied, with and without a spread footing.

**Equipment** (Group of 5)

1 claw hammer

**Supplies** (Group of 5)

1 brick
1 sheet metal foundation wall
1 4″ x 4″ wood spread foundation
1 plastic site tray with sand
1 pc. 3/8″ x 5″ x 5″ plywood
4 4d box nails



PRESS FRAME INTO THE SAND. THIS REPRESENTS A SUPERSTRUCTURE AND FOUNDATION WITH NO FOOTING

Fig. 37-1. This Represents a Superstructure and Foundation with No Footing

## Preparing to Work

1. Get the equipment and supplies for your group.
2. Smooth out an area about 6″ x 6″ in the sand.

## Testing Without Footing

3. Place the metal frame (foundation wall) on edge in the 6″ x 6″ area, Fig. 37-1. This represents a foundation resting on a bearing surface with no footing.
4. Now lay the brick on top of the "foundation." This represents the weight of a superstructure.
5. Press on the brick for more weight. See Fig. 37-1.
6. Remove the brick and metal, and smooth out the sand.

## Testing the Spread Footing

7. Place the spread footing on the sand, Fig. 37-2.
8. Set the metal foundation on the footing.
9. Put the brick on top of the metal again and press down. See Fig. 37-2.

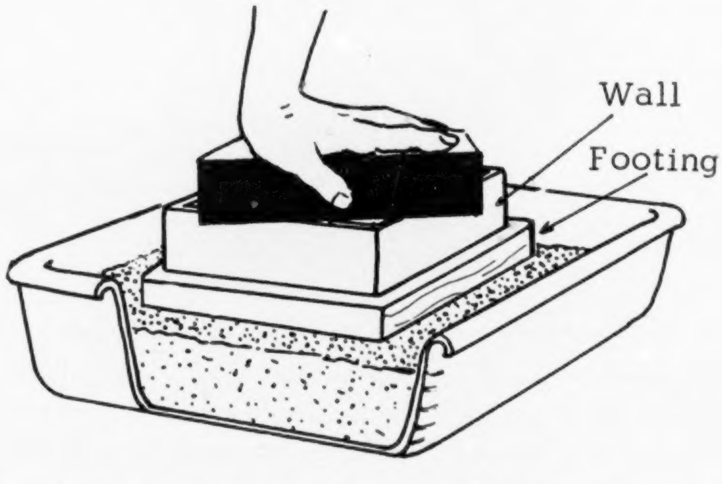


Fig. 37-2. Spread Footing in Place under Structure

## Questions

1. What happened to the foundation walls when the footing was used?

2. What would you say is the purpose of the footing?

3. Is this a sample of a floating foundation, spread footing, or a pile cap foundation?

4. What is the difference between this foundation and a pile cap foundation?

5. The wood represented the

6. The metal strip represented the

## Problem 2

### Objective:

Given a model floating footing and load, find out what happens to the bearing surface when a load is applied to a floating footing.

### Preparing to Work

1. Remove the metal, wood, and brick from the tray. What happened to the bearing surface under the wood "footing"?

2. Smooth out the area. Place the 3/8" x 5" x 5" sheet (floating footing) on the sand.

### Testing the Footing

3. Set the metal foundation on the hardboard.
4. Put the brick on the foundation and press down. See Fig. 37-3.

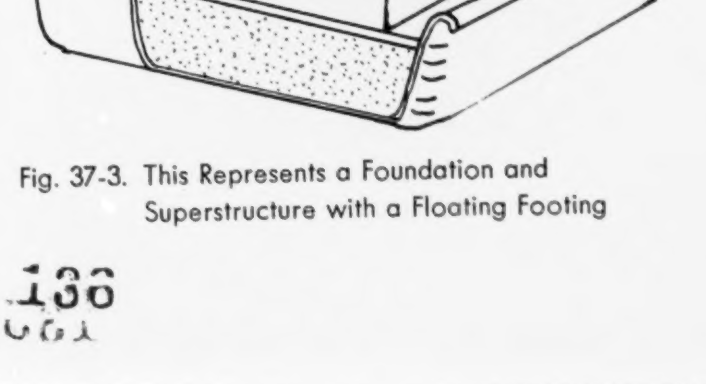


Fig. 37-3. This Represents a Foundation and Superstructure with a Floating Footing

## Cleaning Up

5. Return all equipment and supplies, and clean the work area.

## Questions

1. What happened to the foundation when a floating footing was used?

2. What would you say is the purpose of the footing?

3. Is this a sample of a floating footing, a spread footing, or a pile cap footing?

4. What is the difference between this foundation and a pile cap footing?

5. The wood sheet represented the

6. The metal strip represented the

7. Remove the metal, wood, sheet and brick from the tray. What happened on the bearing surface under the footing?

**ACTIVITY 38A & B**

# Building Forms

Starting today, and for the next several weeks, you will be working on full-sized building projects. You will begin by building footing and column forms. You will have 2 days to complete the forms.

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | tape *or* folding rule |
| 1 | pencil |
| 1 | try square |
| 1 | claw hammer |
| 1 | crosscut saw |
| 1 | ripsaw |

**Supplies** (Group of 5)

* see Fig. 38-2, Footing Form Bill of Materials

**Problem 1**

## Objective:

Using the equipment, supplies, and drawings for a footing form, measure, mark, saw, and assemble the pieces to construct a footing form.

**Safety Precautions**

1. When starting a saw cut, guide the blade with your thumb knuckle. Keep your fingers away from the cutting edges.
2. Start a saw cut with a backward stroke.
3. To start a nail, tap it lightly, remove your hand and complete the nailing.
4. If you injure yourself, report to your teacher for First Aid treatment.

## Building Footing Forms

1. Study Fig. 38-1, Footing Form and Base. Study Fig. 38-2, Footing Form Bill of Materials. Obtain the equipment and materials.
2. Lay out, mark, and saw the form facings (A, B, C, D) to length. See Fig. 38-2.
3. Lay out, mark, and saw the base (E) to size. See Fig. 38-2.

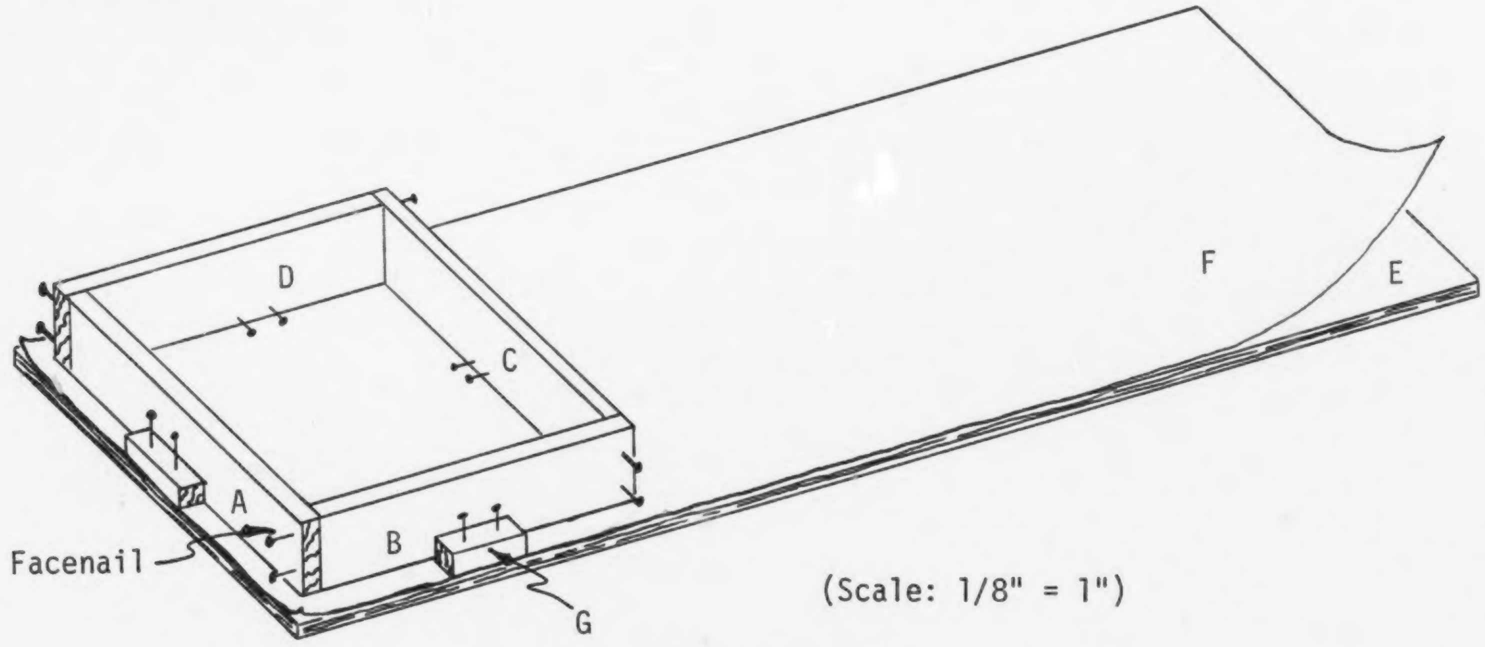


Fig. 38-1. Footing Form and Base

Fig. 38-2. Footing Form Bill of Materials

| Name | Qty. | Sizes |
|---|---|---|
| Facing A, B, C, D | 4 | ¾″ x 3″ x 12¾″ |
| Base E | 1 | ½″ x 15½″ x 48″ ply. |
| Base cover F | 1 sht. | 16″ x 48″, 15 lb building felt |
| Nails | 20 | 6d common *or* box |
| Cleats G | 4 | ¾″ x 1″ x 3″ wood |

4. Face nail the form facing (A, B, C, D) together. See Fig. 38-1.
5. Lay out, mark, and cut the building felt (F) to size. See Fig. 38-2. Building felt is usually not used in form construction. You are using building felt to protect the base material so it can be used as subflooring later.
6. Cover the base (E) with building felt. See Fig. 38-1.
7. Place the form on the base and locate the cleats in position. See Fig. 38-1.
8. Nail the cleats to the base. Then nail the form to the cleats. See Fig. 38-1.

**Problem 2**

## Objective:

Using the equipment, supplies, and drawings for a column form, measure, mark, saw and assemble the pieces to construct a column form.

## Building Column Forms

1. Check with your teacher to see if the column is needed. Only four columns are needed for all classes.
2. Study Fig. 38-3, Column Form. Study Fig. 38-4, Column Form Bill of Materials. Obtain the equipment and materials.
3. Lay out, mark, and saw the column facings (A) to size. See Fig. 38-4.
4. Lay out, mark, and saw the braces (B) to size. See Fig. 38-4.
5. Face nail the column facings (A) together. See Fig. 38-3.
6. Face nail the braces (B) to the column form (A). See Fig. 38-3.

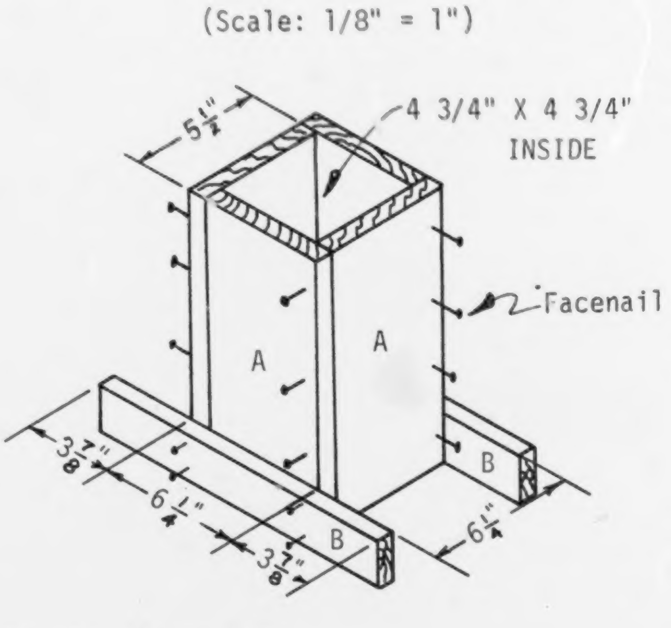


Fig. 38-3. Column Form

Fig. 38-4. Column Form Bill of Materials

| Name | Qty. | Sizes |
|---|---|---|
| Facing A | 4 | ¾″ x 5½″ x 12″ |
| Brace B | 2 | ¾″ x 2″ x 14″ |
| Nails | 2 doz. | 6d common *or* box |

**ACTIVITY 39**

# Setting Reinforcement

Today you will prepare and set reinforcement steel in the footing forms.

**Equipment** (Group of 5)

| | |
|---|---|
| 2 pr. | side cutter pliers |
| 1 | 12″ rule |
| 1 | cold chisel |
| 1 | claw hammer |
| 1 | ⅝″ speed bit |
| 1 | hand *or* electric drill |
| 1 | hacksaw |
| 1 qt. | 30W motor oil |
| | rags |

**Supplies** (Footing Group of 5)

* see Fig. 39-2 and 39-6, Footing Reinforcement Bill of Materials

**Problem 1**

**Safety Precautions**

1. Always be careful when working with rod and wire so that the ends do not strike anyone in the face or eyes.
2. Be sure to hold the end of the wire when cutting it.

## Objective:

Using a footing form that requires setting reinforcement and a drawing, measure, mark, cut, and tie the steel rods in the form.

## Preparing Reinforcement Materials

1. Study Fig. 39-1, Footing Reinforcement. Study Fig. 39-2, Footing Reinforcement Bill of Materials. Get the equipment and materials.
2. Layout, mark, and saw the ⅜″ steel reinforcement rods to length. See Fig. 39-2.
3. Lay out, mark, and cut the 10″ highchair wire to length. See Fig. 39-2.
4. Cut 10 lengths of tie wire about 4″ long.

## Making Highchairs

5. Study Fig. 39-3, Making Highchairs.

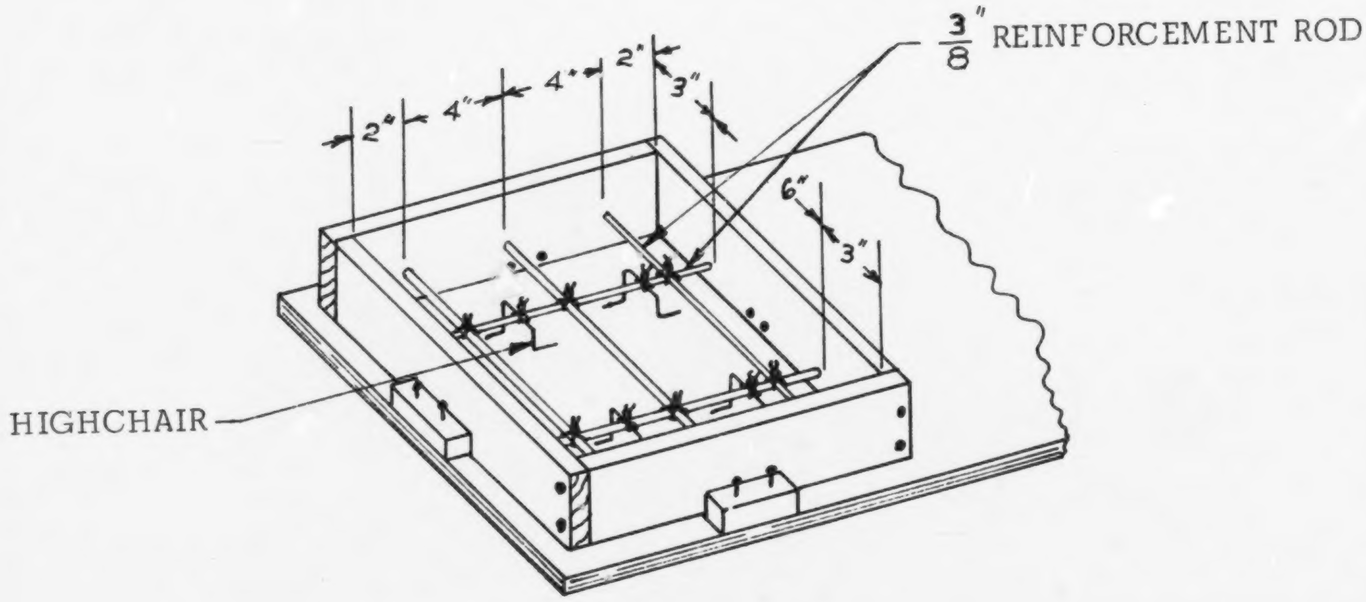


Fig. 39-1. Footing Reinforcement

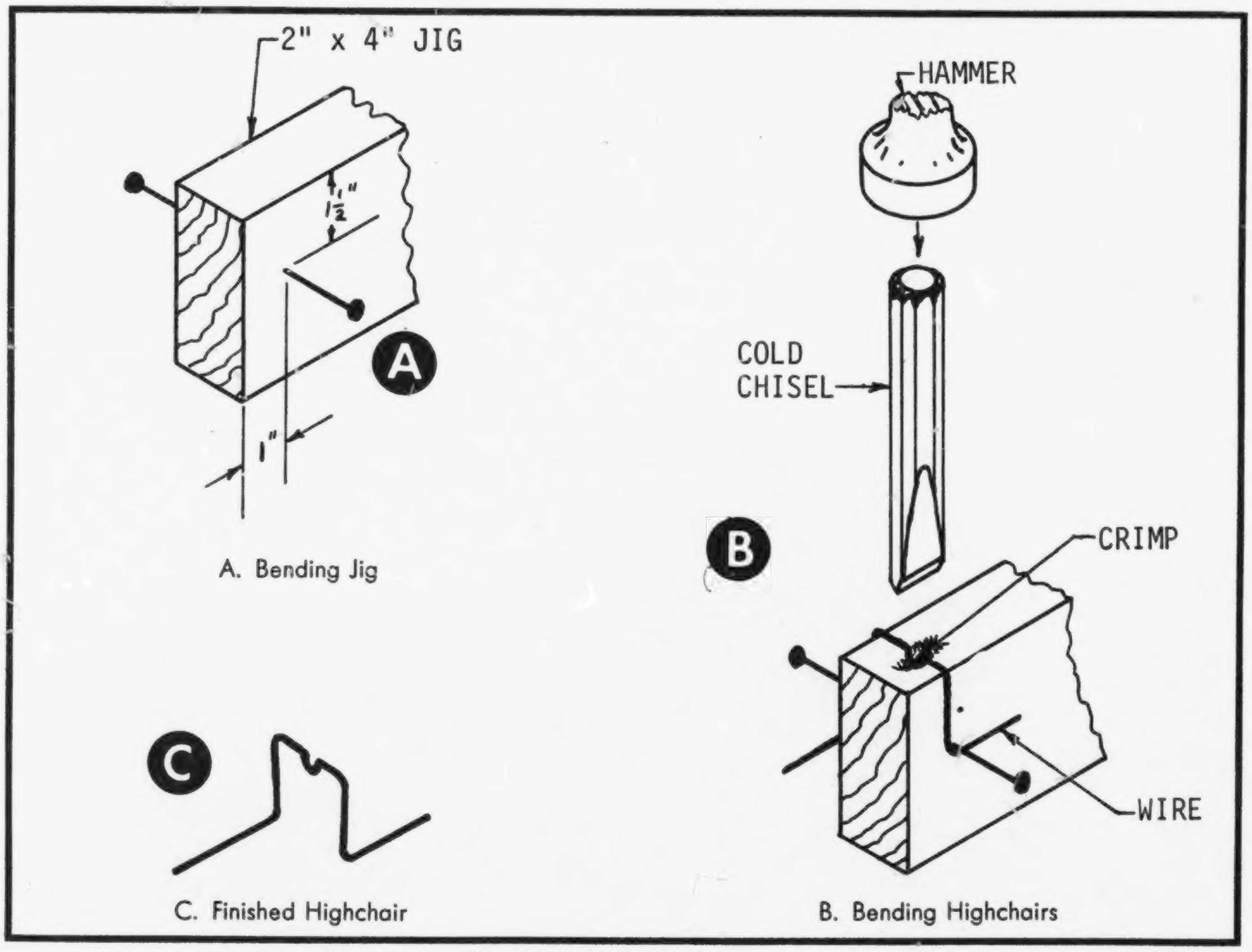
Fig. 39-2. Footing Reinforcement Bill of Materials

| Name | Qty. | Sizes |
|---|---|---|
| Steel reinforcement rod | 5 | ⅜″ x 11½″ |
| Highchairs | 4 | 10″ lengths of coat hanger wire |
| Tie wires | 10 | 4″ lengths, 16 gauge black iron wire |
| Footing form | 1 | 3″ x 12″ x 12″ (inside, wood form) |
| Base | 1 | ½″ x 15½″ x 48″ plywood |

6. Make the bending jig. See "A" in Fig. 39-3.
7. Bend each piece of 10′ wire into highchairs. See "B" in Fig. 39-3. Crimp the center of the highchair by striking it with a cold chisel and hammer. See "B" in Fig. 39-3.
8. Your finished highchair should look like "C" in Fig. 39-3.

## Setting Reinforcement

9. Set the reinforcement rod A on the highchairs and tie. See Fig. 39-4.
10. Measure the A rod placement in the form. See Fig. 39-1.
11. Measure and place the remaining 3 rods on top of the A rods. See Fig. 39-1.
12. Tie the rods in place. See Fig. 39-4.



A. Bending Jig

C. Finished Highchair

B. Bending Highchairs

Fig. 39-3. Making Highchairs

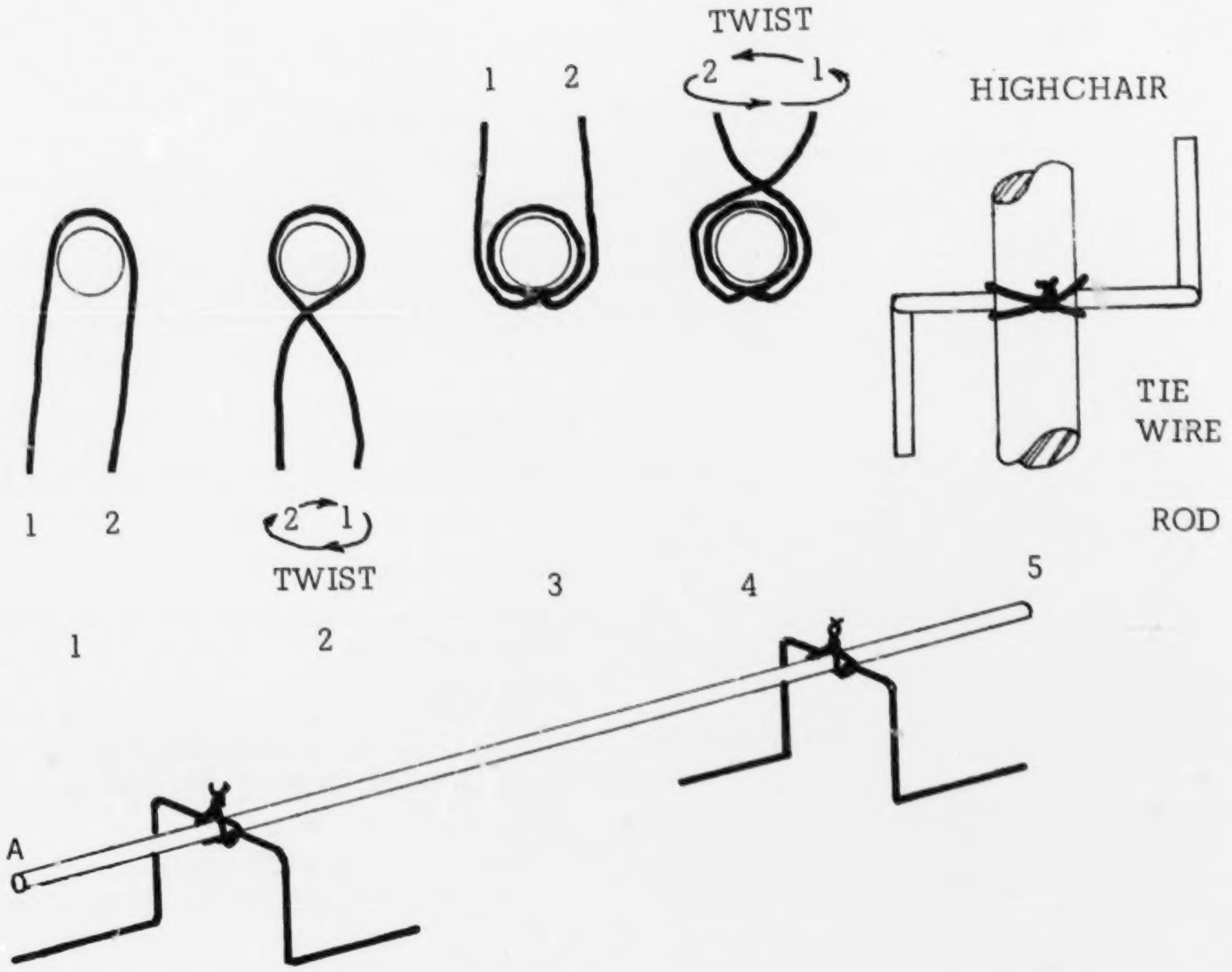

TWIST
1
2
2
1
HIGHCHAIR
TIE WIRE
ROD
1
2
2
1
TWIST
3
4
5
1
2
A

Fig. 39-4. Tying Rod

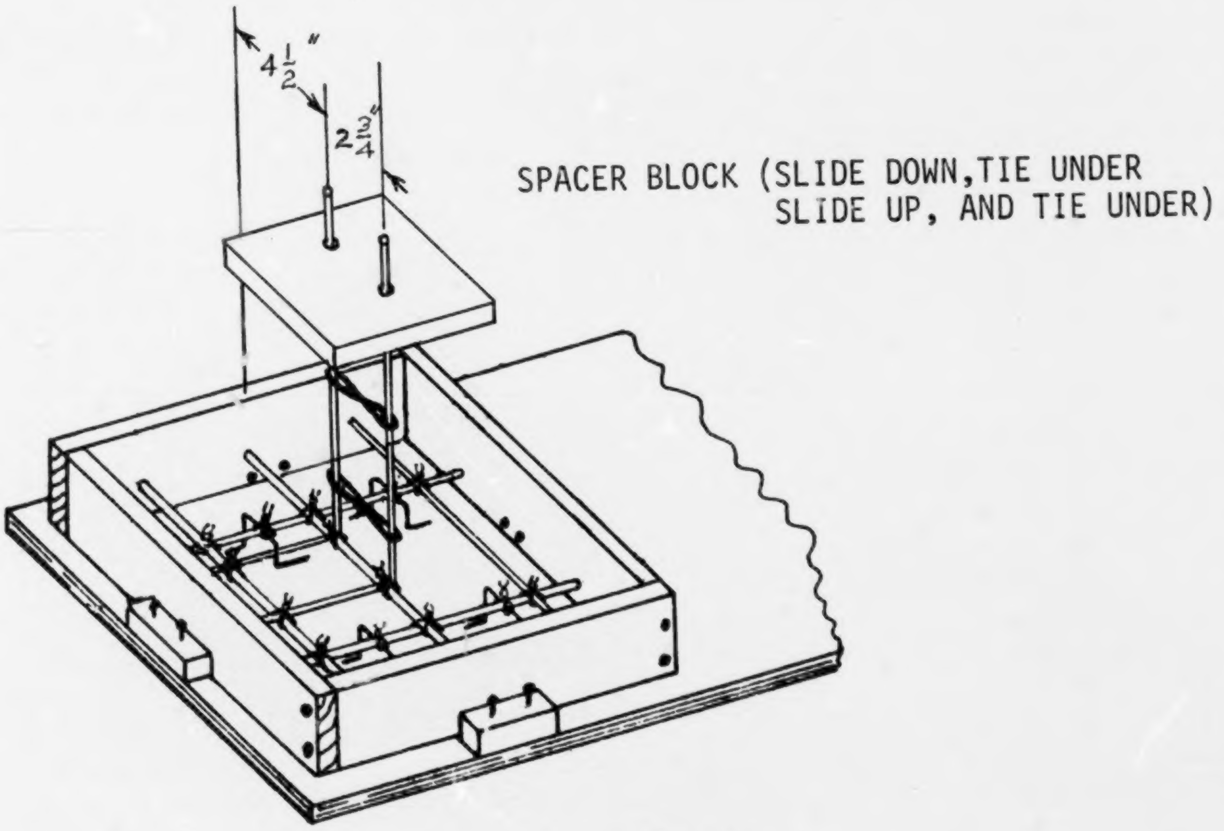

$4\frac{1}{2}$"
$2\frac{3}{4}$"
SPACER BLOCK (SLIDE DOWN, TIE UNDER
SLIDE UP, AND TIE UNDER)

Fig. 39-5. Column Reinforcement

Fig. 39-6. Column Reinforcement Bill of Materials

| Name | Qty. | Sizes |
|---|---|---|
| Steel reinforcement rod | 2 | ⅜″ x 18″ |
| Tie wires | 2 | 16″ lengths, 16 gauge black iron wire |
| | 4 | 4″ lengths, 16 gauge black iron wire |
| Spacer block | 1 | ¾″ x 6″ x 6″ wood |

### Treating Forms

13. Lift the reinforcement out of the form.
14. Apply oil to a rag and spread it on the inside of the form. Replace the reinforcement.
15. Clean up and store all equipment and supplies.

## Problem 2

### Objective:

Using a column form that requires setting reinforcement, measure, mark, cut, bend, and tie the steel rods to the footing reinforcement steel.

### Preparing Reinforcement Materials

1. Study Fig. 39-5, Column Reinforcement. Study Fig. 39-6, Column Reinforcement Bill of Materials.
2. Lay out, mark, and saw the ⅜″ steel reinforcement rods to length. See Fig. 39-6.
3. Cut 4 lengths of tie wire about 4″ long. Cut 2 tie wires 16″ long.

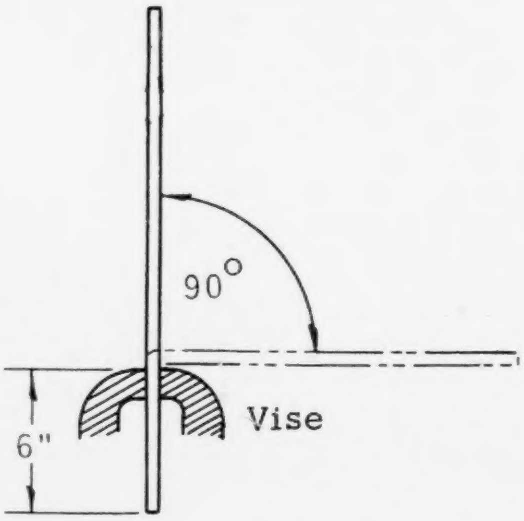


Fig. 39-7. Bending Rod

### Bending Rod

4. Bend each rod 6″ from one end. See Fig. 39-7.

### Making Spacer

5. Lay out, saw, and drill one spacer block. See Fig. 39-8.

### Setting Reinforcement

6. Locate and tie both column rods to the footing reinforcement. See Fig. 39-6 and Fig. 39-4.
7. Slide the spacer block over the top of the rods. Slide it to the bottom. Raise it about 2″ and wrap the tie wire back and forth around the rod to form an X. See Fig. 39-5. Raise the spacer block about 3″ from the top and tie another X under the block. Remove the block.
8. Clean up and store all equipment and supplies.

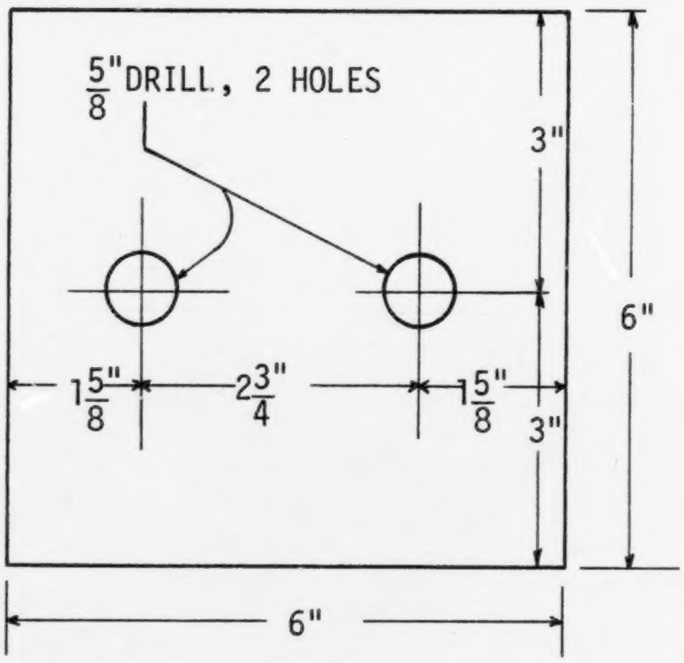


Fig. 39-8. Spacer Block Detail

## ACTIVITY 41

# Placing and Finishing Concrete

### Problem 1

### Objective:

Using the necessary equipment and supplies and a footing form set with reinforcement steel, proportion, mix, test, place, rod, screed, and finish concrete to make a concrete footing.

**Equipment** (Per class)

| | |
|---|---|
| 1 | mortar box (for mixing concrete) |
| 1 | wheelbarrow |
| 1 | hoe *or* shovel |

**Equipment** (Group of 5)

| | |
|---|---|
| 1 | screed 1″ x 3″ x 18″ wood |
| 1 | steel cement finishing trowel |
| 1 | quart measure |
| 1 | 2′ steel rod *or* 1″ x 1″ x 2′ scrap stick |

**Supplies** (Group of 5)

| | |
|---|---|
| 1 | footing form 3″ x 12″ x 12″ |
| 1 | 16 oz. paper cup (slump cone) |
| 1 qt. | cement |
| 3 qt. | sand |
| 4 qt. | gravel |
| 1 | large plastic sheet *or* 15 lb. building felt |

### Preparing to Work

1. Check to see if your form is oiled.
2. Check to see if the form is held firmly in place by the base cleats.
3. Spread the plastic sheet or building felt under your form.
4. Check with your teacher for your mixing turn.

### Mixing Concrete

4. Place 16 cups (4 qt.) gravel, 12 cups (3 qt.) sand, and 4 cups (1 qt.) cement in one end of the mortar box.
5. Thoroughly dry mix the concrete with a hoe or shovel.
6. Add 1 cup of water and wet mix.
7. Make a slump test. See Fig. 41-1. The concrete should slump about ⅓ the height of the cone. If it does not, add a little more water and mix. Test again.
8. After you have found the correct proportion of water, mix the batch. Shovel the mix into a wheelbarrow.

### Placing Concrete

9. Place the concrete into your form. Return the wheelbarrow to the mixing box.
10. Rod the concrete to work it in between the reinforcement. IMPORTANT: Rod the concrete along the edges of the form. This will work the water and cement out to the edge to give a smooth finish.
11. Screed the concrete, working it down to a flat surface. Work the screed back and forth as you move it toward the end of the form. See Fig. 41-2.

### Finishing Concrete

12. After screeding and toward the end of the period, give the surface a steel trowel finish. Work the trowel over the surface until the surface is smooth. Cover the form with the plastic or building felt sheet for curing.

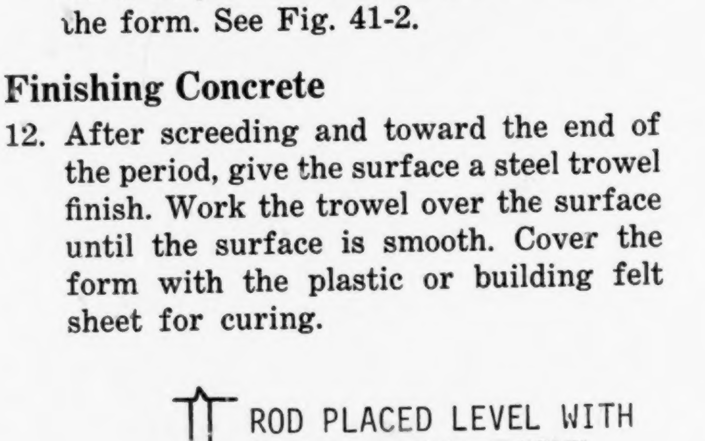


Fig. 41-1. A Slump Cone Test

## Cleaning Up

13. Wash all equipment in water as directed by the teacher.
14. Store all equipment.

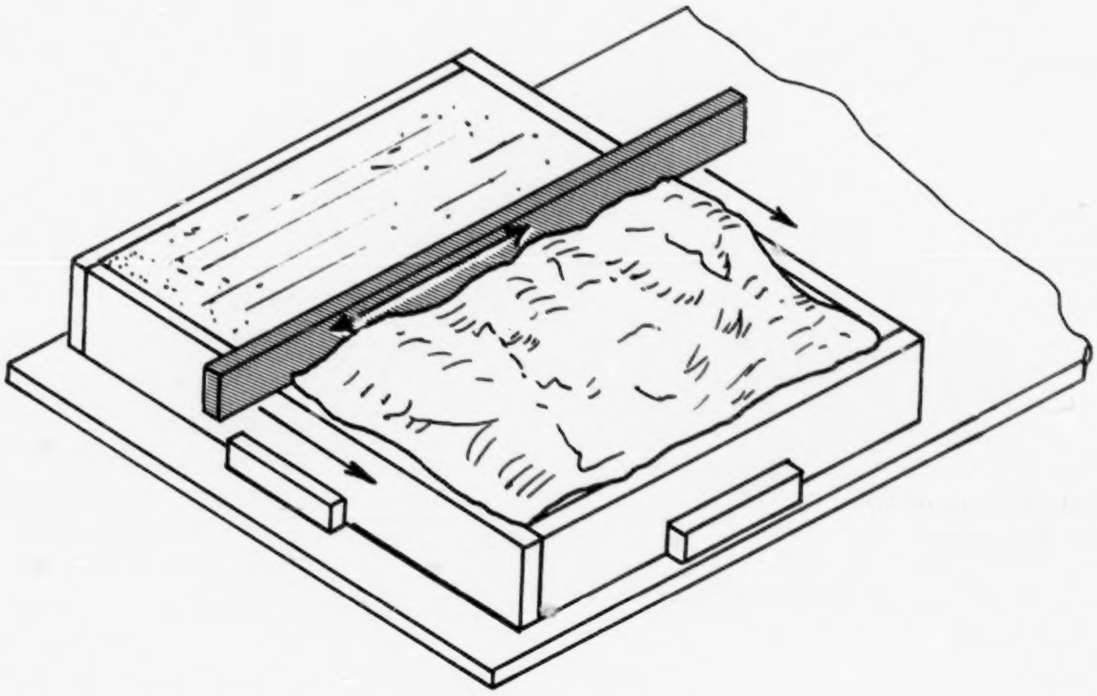


Fig. 41-2. Screeding Concrete

**ACTIVITY 42**

# Completing Foundations

**Problem**

### Objective:

Given the equipment and supplies, remove and clean the forms, and provide for proper curing of the concrete.

**Equipment** (Group of 5)

| | |
|---|---|
| 2 | claw hammers |
| 1 | paint scraper |
| 1 | 12″ wrecking bar |

**Supplies**

| | |
|---|---|
| 1 | plastic sheet |

### Removing and Cleaning Forms

1. The foreman of your group should assign tasks as follows:
   a. Two students will take the footing and column form apart with a wrecking bar.
   b. Two students will remove all nails from the form materials.
   c. One student will scrape the forms to remove any extra concrete, and he will then store the form materials as directed by the teacher.

### Curing Concrete

2. It is important to keep the water from evaporating too rapidly from "green" concrete. To slow down evaporation, place plastic sheeting over the concrete.

### Questions

1. Why is it necessary to be careful when removing forms?

2. Why are the form boards cleaned?

**ACTIVITY 43**

# Building Superstructures

**Problem**

### Objective:

Given various kinds of superstructures and various materials, match each superstructure with a suitable material.

### Choosing Materials

For each superstructure choose a suitable construction material. Show your answers by printing the proper letter in each blank. You will use some materials more than once.

**Superstructures**

1. _____ Wood frame house
2. _____ Dam
3. _____ Steel frame building
4. _____ Solid concrete wall building
5. _____ Airport runway
6. _____ Oil derrick
7. _____ Stone house
8. _____ Highway
9. _____ TV tower
10. _____ Block wall

**Materials**

a. Steel frame
b. Masonry (stone)
c. Mass (earth, concrete)
d. Masonry (concrete block)
e. Concrete (load-bearing)
f. Wood frame

**ACTIVITY 44**

# Building Mass and Masonry Superstructures

## Problem

### Objective:

Using footings and layout directions, measure and mark the footing for the mortar bed, mix mortar, and lay and level concrete block to build a bearing wall.

**Equipment**

| | |
|---|---|
| 2 | brick trowels |
| 1 | jointing tool |
| 1 | 2′ masonry level |
| 1 | hand garden trowel |
| 1 | 12″ rule |
| 1 | chalk line |
| 1 | qt. measure |
| 1 | mortar box (per class) |
| 1 | bucket |

**Supplies**

| | |
|---|---|
| 4 | 8″ x 8″ x 16″ concrete blocks |
| 2 | 8″ x 8″ x 8″ concrete blocks |
| 8 qt. | masonry cement |
| 24 qt. | sand |
| 6 qt. | water |
| 1 | mortar board |
| 1 sht. | building felt 3′ x 6′ *or* equiv. |

## Laying Out Work

1. Remove the plastic covers from 4 footings and spread them out. Place the *footings on the sheets.*
2. Using a rule and chalk line, mark a line

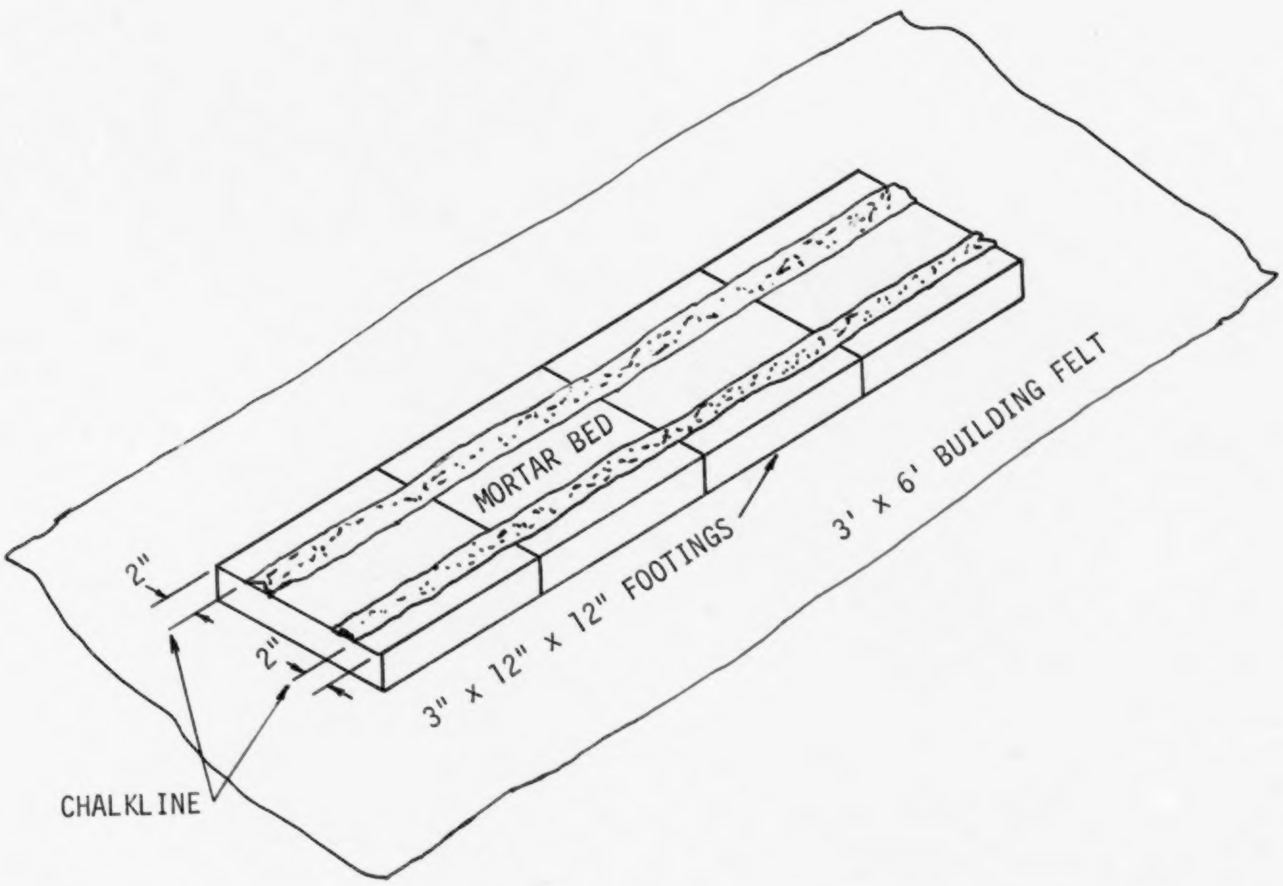


Fig. 44-1. Layout for Mortar Bed

on top of the footing, 2″ in from one edge and running parallel to it. See Fig. 44-1. Mark another line 2″ in from the opposite edge.

## Mixing Mortar

3. Place 8 qt. of masonry cement and 24 qt. of sand in the mortar box.
4. Thoroughly dry mix the cement and sand.
5. Add water according to you teacher's directions.
6. After the mortar is mixed, place about 6 to 8 trowelsful on your mortar board.

## Laying Block

7. Lay a full mortar bed on the footing between the chalk lines as shown in Fig. 44-1.
8. Follow the block laying procedure that your teacher has demonstrated. Lay 2 courses of block with 3/8″ joints as shown in Fig. 44-2.

## Leveling and Plumbing

9. Level and plumb the blocks as you lay them. Check the alignment with a straightedge or level. See Fig. 44-3.
10. Check the mortar joints of the concrete blocks. When the mortar becomes thumbnail hard, tool the joints. See Fig. 44-4.

## Cleaning Up

11. Since the concrete blocks will be needed for the next class, you will have to salvage the bearing wall.
12. Remove the blocks. With a masonry

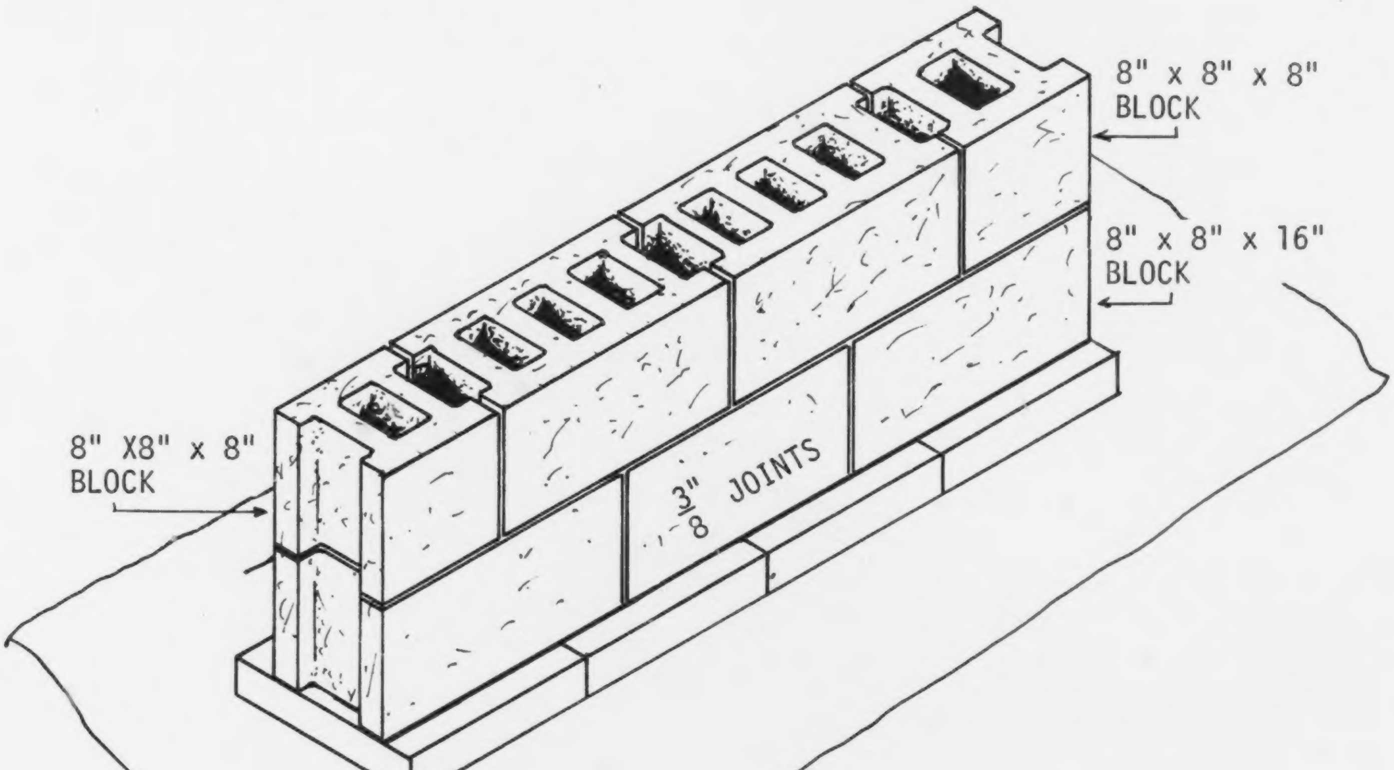


Fig. 44-2. Concrete Block Bearing Wall

trowel, scrape the mortar into a bucket. Scrape the mortar off the top of the footing.

13. Stack the blocks near the footing for the next class.
14. Wash all tools and equipment thoroughly in water. Dispose of the cleaning water according to your teacher's instructions. Return the tools and equipment to their proper places.

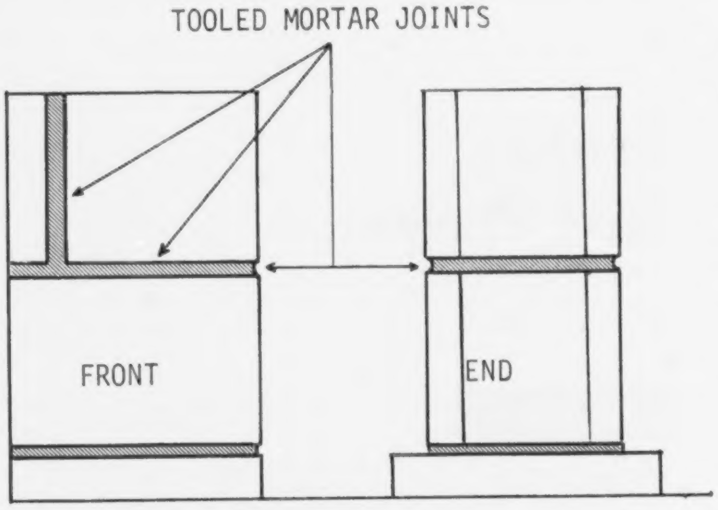

TOOLED MORTAR JOINTS
FRONT
END

Fig. 44-4. Tooled Mortar Joints

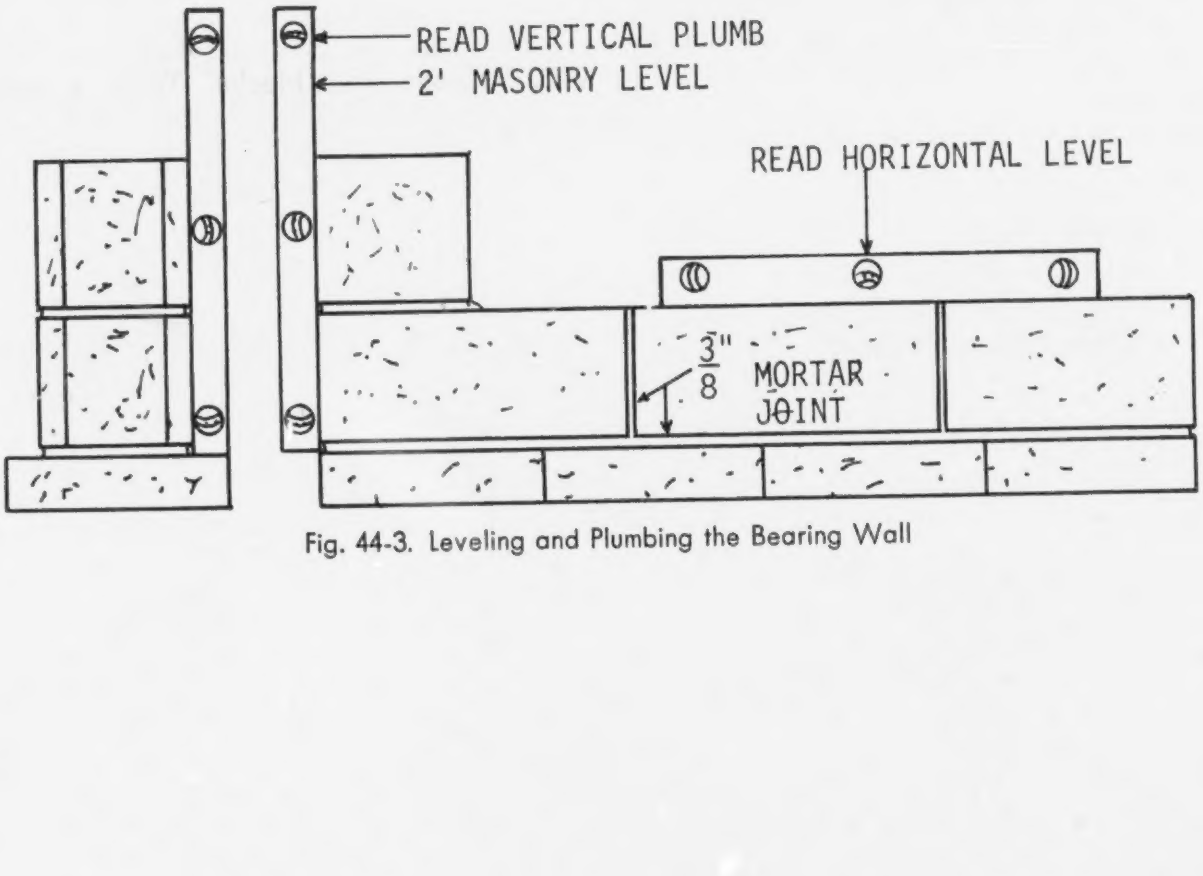

READ VERTICAL PLUMB
2' MASONRY LEVEL
READ HORIZONTAL LEVEL
3/8" MORTAR JOINT

Fig. 44-3. Leveling and Plumbing the Bearing Wall

**ACTIVITY 45A**

# Erecting Steel Frames

**Problem**

## Objective:

Given a set of working drawings:

a. Read the drawings.

b. Lay out footings and columns for structural steel.

c. Assemble steel columns to the concrete footings.

d. Assemble brackets to the steel columns.

**Equipment** (Per class)

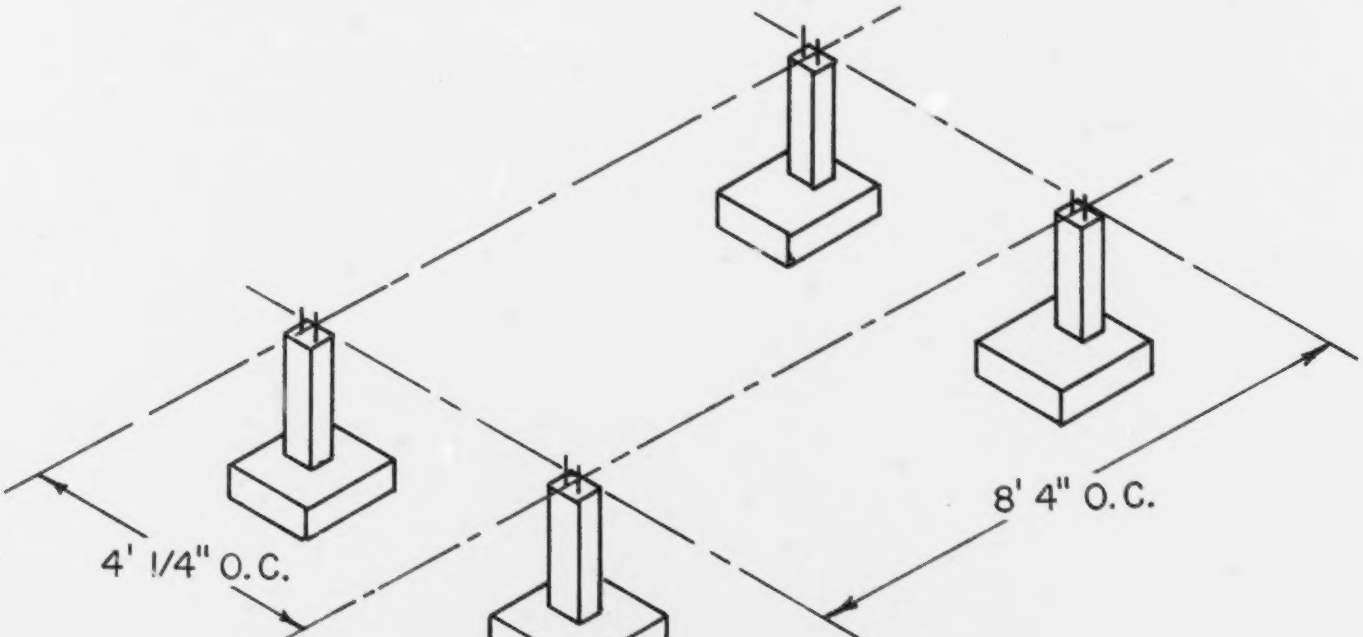
| | |
|---|---|
| 4 | 12″ drift pins, tapered from ¼″ to ½″ diameter *or* spud wrench with same taper |
| 1 | 12′ steel measuring tape |
| 4 | adjustable wrenches *or* 9/16″ socket wrenches *or* spud wrenches |

**Supplies** (Per class)

| | |
|---|---|
| 2 pcs. | 4″ x 2.79″ x 4′ std. I-Beam |
| | H-beams or wide angle I-beams, as follows:<br>4 pcs. 4″ sq. x 1′<br>2 pcs. 4″ sq. x 8′ |
| 20 | ⅜″ steel washers |
| 4 | concrete footings with concrete columns and anchor bolts |
| 8 | ¼″ angle iron top brackets (4 holes) |
| 8 | ¼″ angle iron base brackets (2 holes) |
| 48 | ⅜″ x 1½″ machine bolts, square head, with hex nut |
| 40 | ⅜″ x 1″ machine bolts, square head, with hex nut |

## Reading Drawings

1. Before the erection of the structure be-



3/8" ANCHOR BOLTS
3" ON CENTER WITH 1" ABOVE COLUMN

Fig. 45A-1. Column Layout for Beams

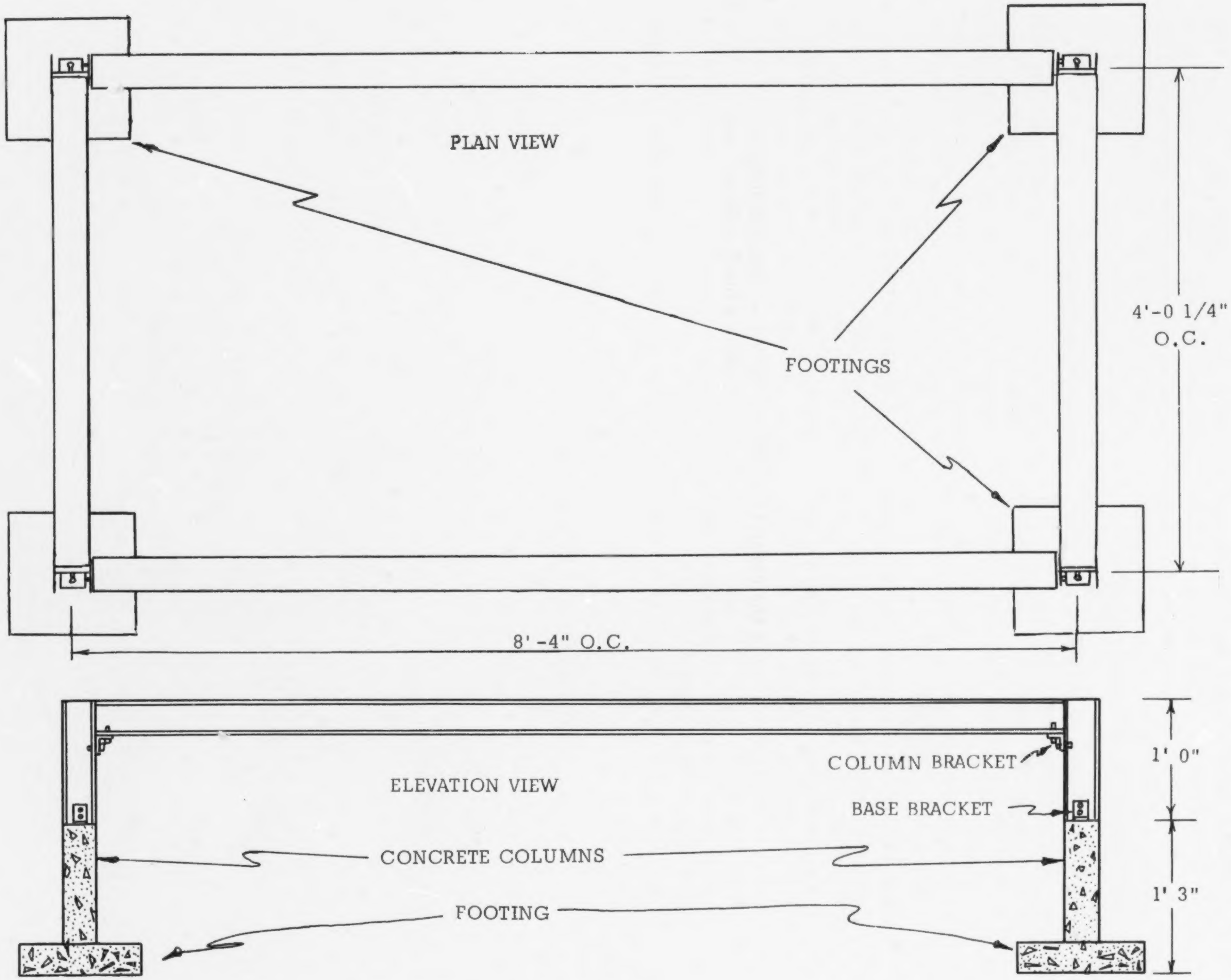

PLAN VIEW
FOOTINGS
4'-0 1/4"
O.C.
8'-4" O.C.
ELEVATION VIEW
COLUMN BRACKET
BASE BRACKET
CONCRETE COLUMNS
FOOTING
1' 0"
1' 3"

Fig. 45A-2. Steel Frame

gins, *each* student must study the working drawings. See Figs. 45A-1, 45A-2, and 45A-3. These drawings give the construction details and a completed view of the structure at different angles.

**Safety Measures**

1. Use care in moving concrete.
2. Use care in handling structural steel. It is heavy and has sharp edges.
3. Do not try to lift more than you are able.

## Laying Out

2. Place the footings in the middle of the floor. All students in the class will have to help with this moving operation.
3. Using the steel measuring tape, move the footings until you have them placed according to the dimensions given in Fig. 45A-1. Be sure there is enough working area around the footing. The distance between centers of anchor bolts must be measured accurately so that the steel beams will fit. See Figs. 45A-1 and 45A-2.

## Assembling Brackets

4. Divide into four groups and get the necessary equipment and supplies. Each group will prepare to bolt the angle brackets to one of the four steel columns. (These brackets will serve as fasteners and supports for the steel beams.) Notice in Fig. 45A-3 that the steel columns are already drilled for the brackets. The base brackets are used to bolt the columns to the footings. They can be identified as having two holes, one in each side of the angle. The support brackets fit at the tops of the steel columns. They have four holes, two in each side of the angle.
5. Match the base brackets with the bases

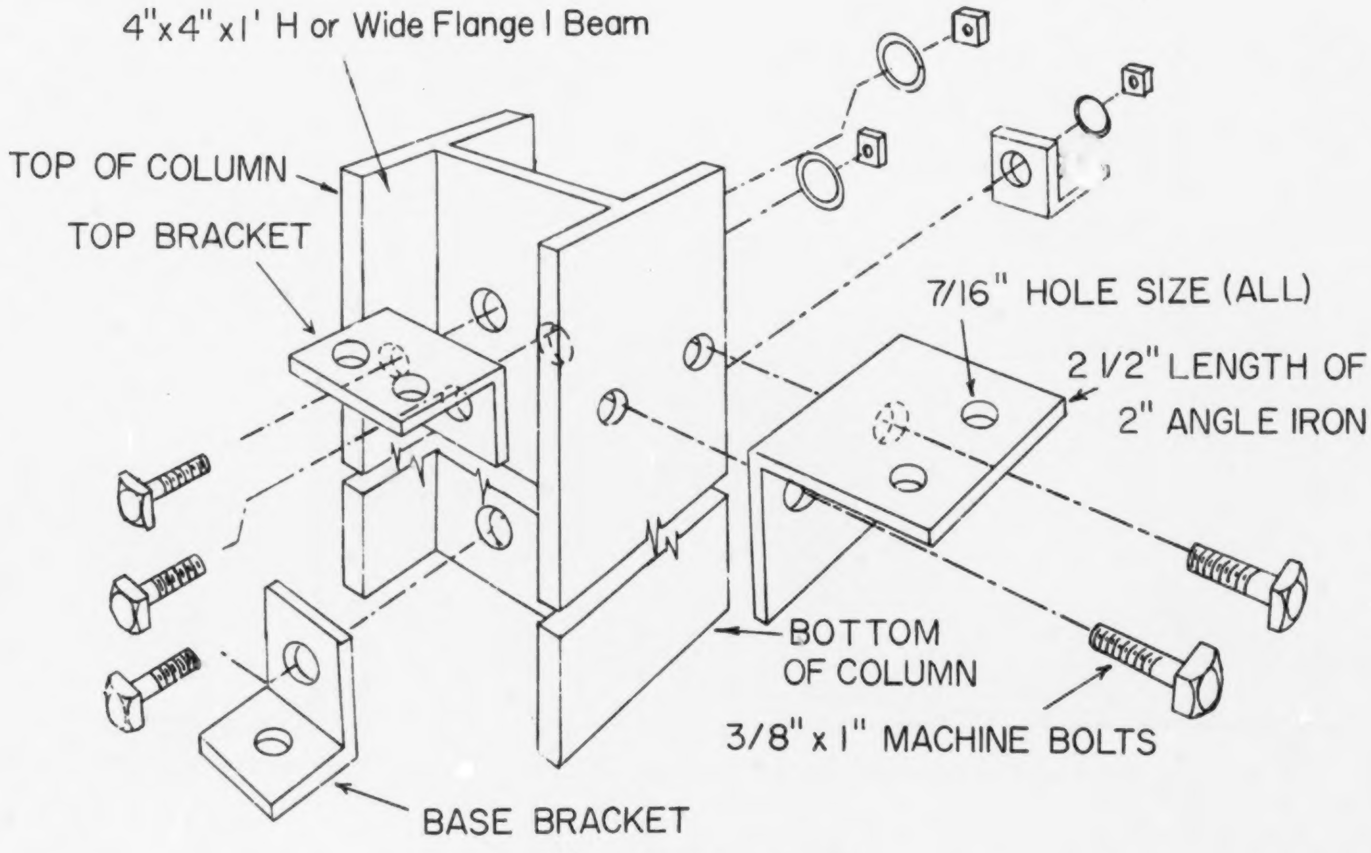
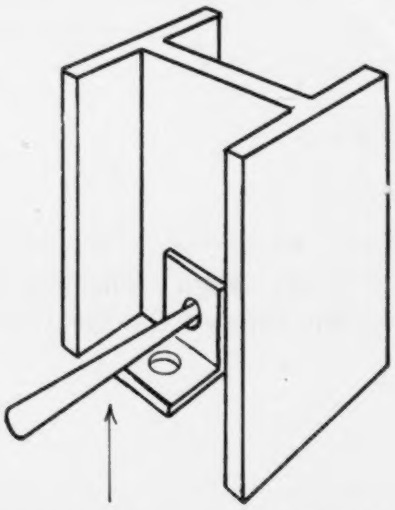


Fig. 45A-3. Assembling Brackets

of the columns as shown in the drawing. You may need to use a tapered drift pin or spud wrench to align the holes. See Fig. 45A-4.

6. Once you have the holes aligned, insert the bolt through both brackets with the web of the steel column between them. Use a washer under each nut wherever possible.
7. Tighten the nuts only finger tight.



TAPERED DRIFT PIN FOR HOLE ALIGNMENT

Fig. 45A-4. Base Plate and Column Adjustment

8. To assemble the top support brackets, use the same procedure as that given for the base brackets. CAUTION: Place the bolt heads through the brackets as shown in Fig. 45A-3.

## Questions

1. When you read construction drawings, you often find dimensions given with the abbreviation "O.C."; for example, 16″ O.C. What does the abbreviation "O.C." mean?

2. Why is it a good idea to have the nuts exposed on the outside of the frame at the corner?

**ACTIVITY 45B**

# Erecting Steel Frames

Today you will complete the erection of the steel frame onto the concrete columns. You will work in three groups, each group completing a different problem.

## Problem 1

### Objective:

*Group 1* will show their skill in placing the structural materials on the site.

**Equipment** (Group 1)

| | |
|---|---|
| 2 | 4" x 8'0" I-beams |
| 2 | 4" x 4'0" I-beams |
| 4 | 4" x 1' preassembled I-columns |
| 4 | concrete footings and columns (should already be in place) |
| 2 | stacking timbers (2" x 4" x 2') |

### Delivering Materials

1. The first job of Group 1 will be placing the structural materials on the site.
2. After delivering the materials to the site, turn to Problem 2.

## Problem 2

### Objective:

*Group 2* will show their skill in hoisting the structural steel members into place on the concrete footings using the *jenny winch boom.*

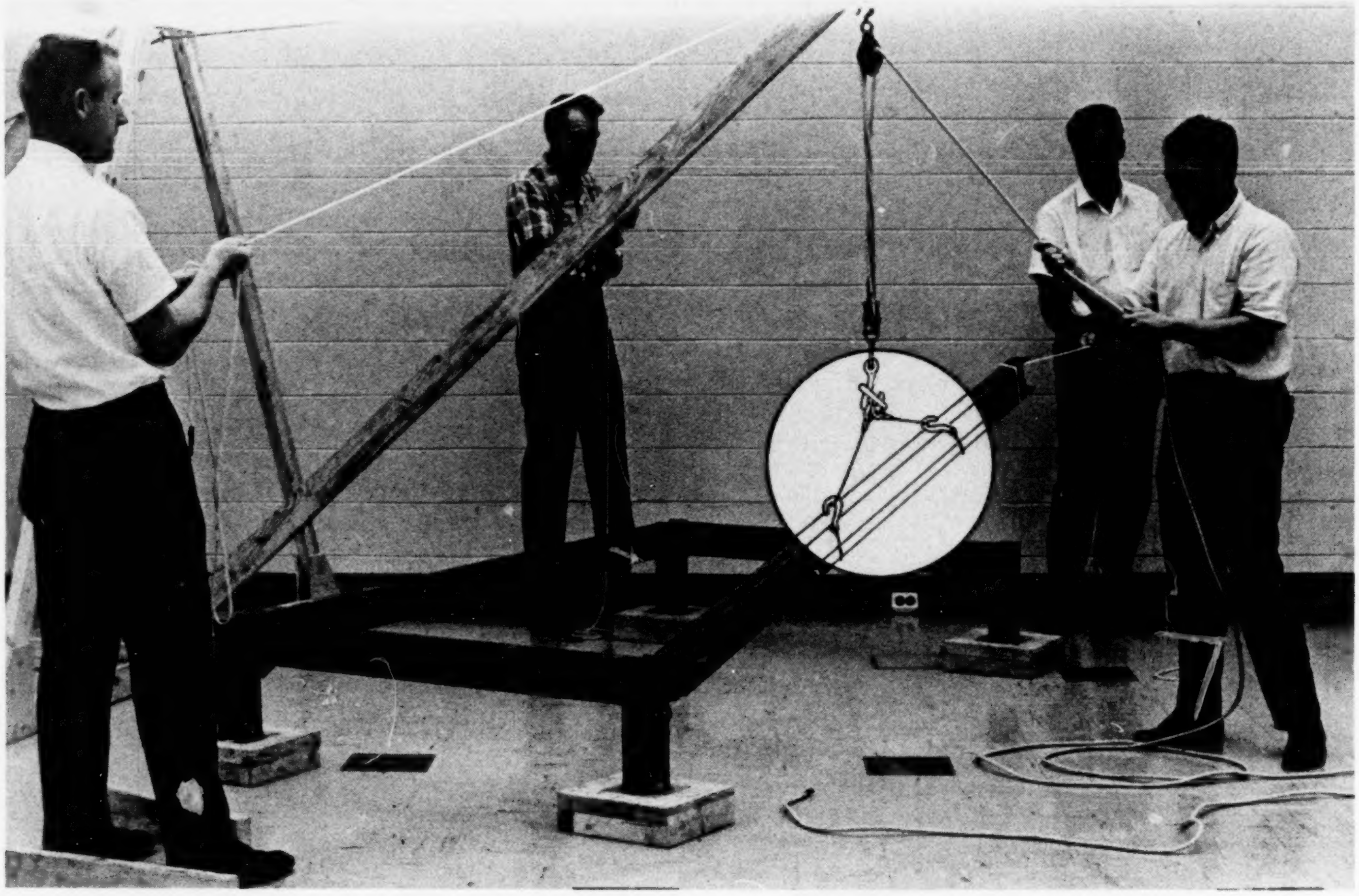


Fig. 45B-1. Steel Group

**Equipment** (Group 2)

| | |
|---|---|
| 1 | jenny winch boom |
| 2 | guy lines (15′ of ¼″ nylon rope) |
| 2 | tag lines (15′ of ¼″ nylon rope) |
| 1 | choker set (¼″ steel cable with hook) |
| 1 | double pulley block and tackle (small) |

## Erecting Steel Frames

1. At least eight workers are needed for this group. Group 2 will be rigging, hoisting, and operating the boom. See Fig. 45B-1.
2. The group foreman should assign jobs so that each member performs one of the following tasks (steps 3 through 8).
3. **Guy line holders:** Two students, one on each side of the boom, are needed to swing the boom to the right or left. The signaler will give you the signals for swinging the boom.
4. **Boom stabilizers:** Two students need to stand at the rear of the boom. This is to prevent the boom from tipping over.
5. **Block and tackle man:** This man's job will be the raising and lowering of loads as the signaler directs.
6. **Choker setter:** A choker is a length of cable with hooks on both ends.
   a. The cable is looped around the load to be lifted, and the hook is set.
   b. The load is hoisted by hooking the cable onto the block and tackle.
   c. The choker setter should set the chokers in the middle of the steel member, then spread them about 1′. When the choker is set correctly, the beam will remain horizontal when hoisted. See Fig. 45B-2. Before setting the choker, mark the center of each beam with chalk to prevent the beam from being lifted off balance.

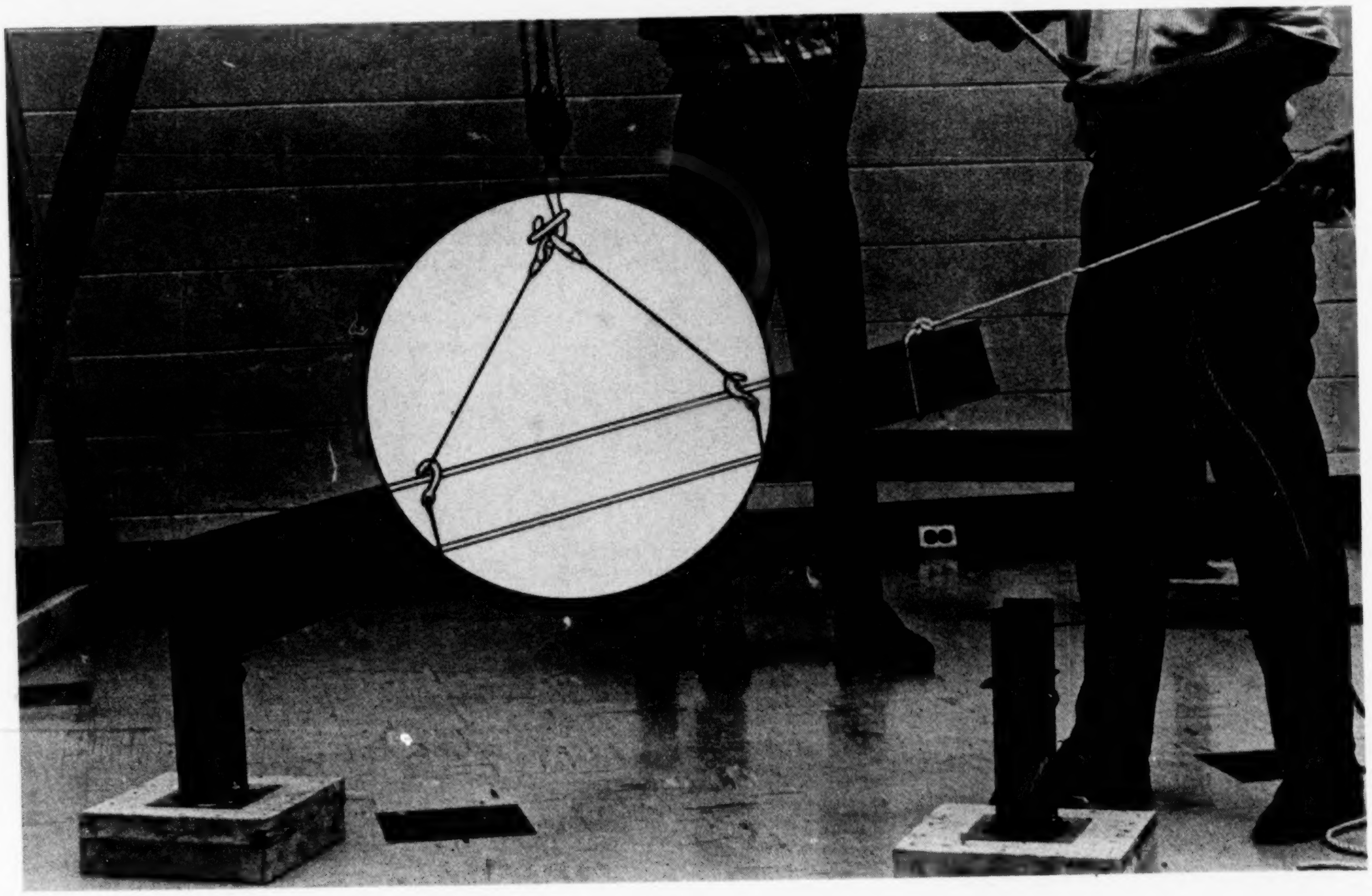


Fig. 45B-2. Choke Set

d. If you can, balance the beams for hoisting.

7. **Tag line holders:** A tag line is a rope tied to the end of the member being hoisted. The tag line holder's job is to control the beam swing and help guide it into position during the hoisting procedure. See Fig. 45B-3.
8. **Signaler:** This worker's job is to give signals or directions to the boom operators and rigging workers. The more commonly used signals are given in Fig. 45B-4.
9. **Boom operator:** This worker's job is to raise and lower the boom.
10. When Group 2 understands these tasks, turn to Problem 5.

## Problem 3

### Objective:

Group 3 will show their skills on leveling, squaring, and plumbing the steel structure.

**Equipment** (Group 3)

| | |
|---|---|
| 1 | 2′ spirit level |
| 1 | 1′ level or smaller |
| 1 | framing square |
| 2 | 3 lb. ball peen hammers |
| 4 | spud wrenches *or* open-end wrenches |
| 4 | ½″ drift pins, if open-end or adjustable wrenches are used rather than spud wrenches. |

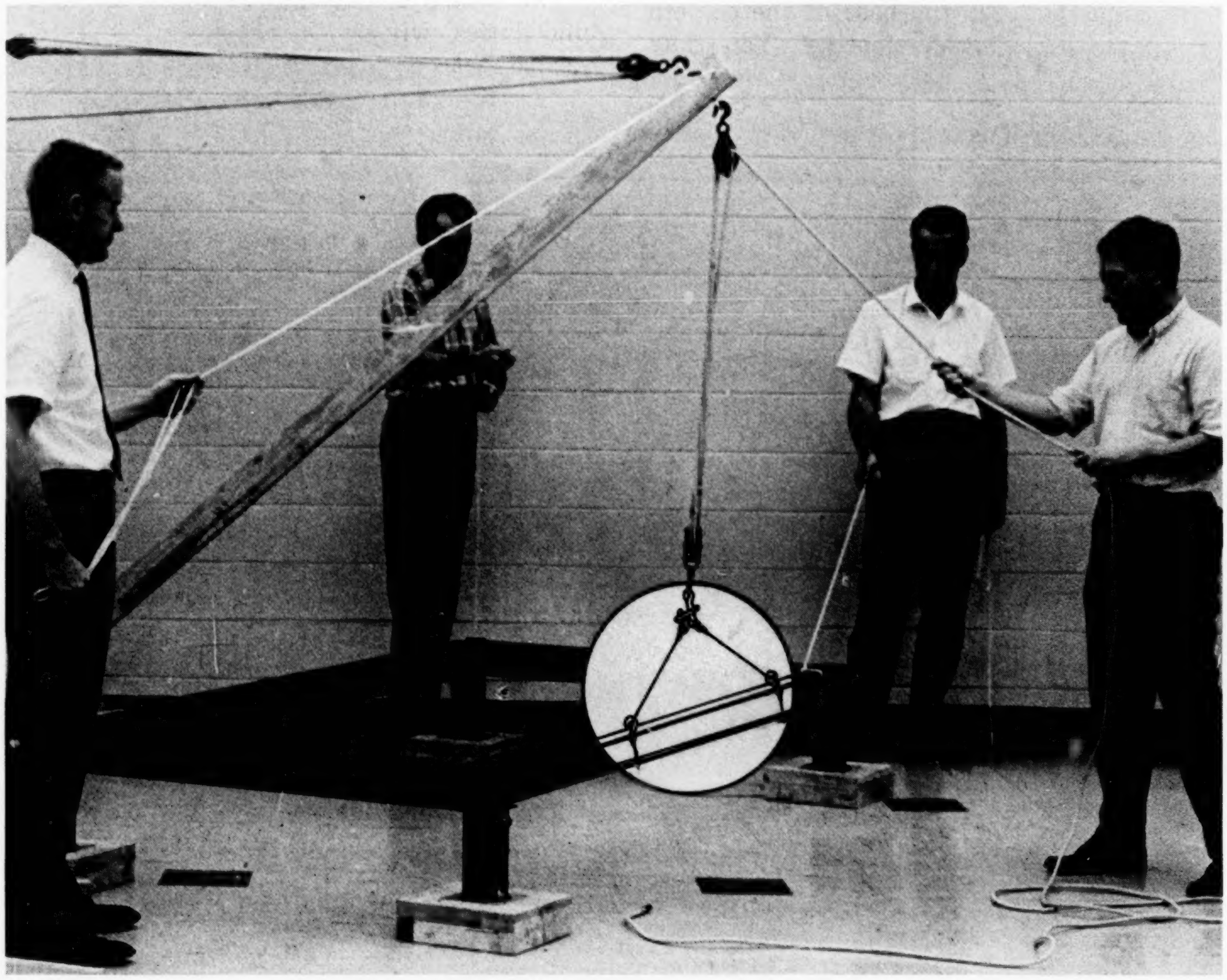


Fig. 45B-3. Tag Line Operation

**Supplies** (Group 3)

assorted metal shims of various thicknesses, cut in 2″ x 4″ sizes *or* printing leads and slugs if available.

## Aligning the Structure

1. Three to four workers are needed to do the aligning. Study Fig. 45B-5.
2. Notice that the nuts have been left finger tight. This will allow you to make minor adjustments, if necessary, in performing steps 3 through 6.
3. The columns should be plumbed first. A 1′ spirit level can be used for this job.
    a. Check the columns on both sides (flange and web) to see if they are plumb.
    b. If a column is not plumb, use metal shims between the base of the column and the concrete footing. You may have to try various thicknesses, or stack several shims, until the column is plumb.
4. When each column is plumbed vertically, Group 3 should tighten the nuts bolting each column to the footing.
5. Next, check the squareness of the structure's corners.
    a. Use the framing square to check all four corners.
    b. If a corner is not square, use a ball peen hammer to tap the beams into alignment.
6. The last job is leveling the horizontal beams. This can be done using the 2′ spirit level.
    a. Check each beam separately for levelness.
    b. If they are not level, tap them in the direction necessary to level them.

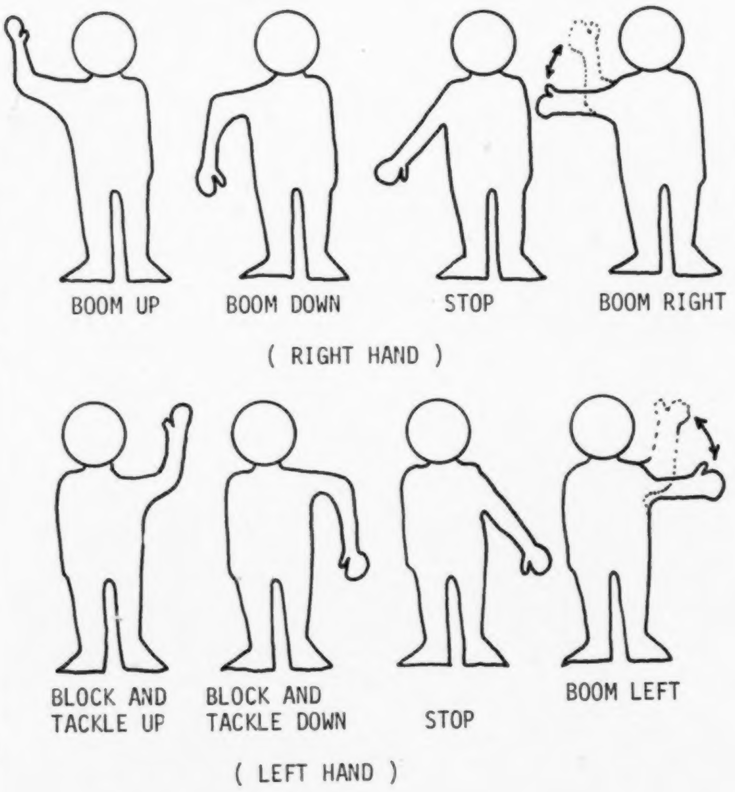


Fig. 45B-4. Signals

## Problem 4

### Objective:

*The entire class* will perform their specific duties, within groups, to assemble the steel structure.

## Final Assembly of the Structure

1. After the footings have been placed in their proper positions, the structural steel can be placed on the site by Group 1.
2. The steel members should be placed on timbers within reach of the boom. It is necessary to have room between the beams so that the choker can be set.
3. The steel columns should be loosely bolted to the concrete column to prevent them from falling over.

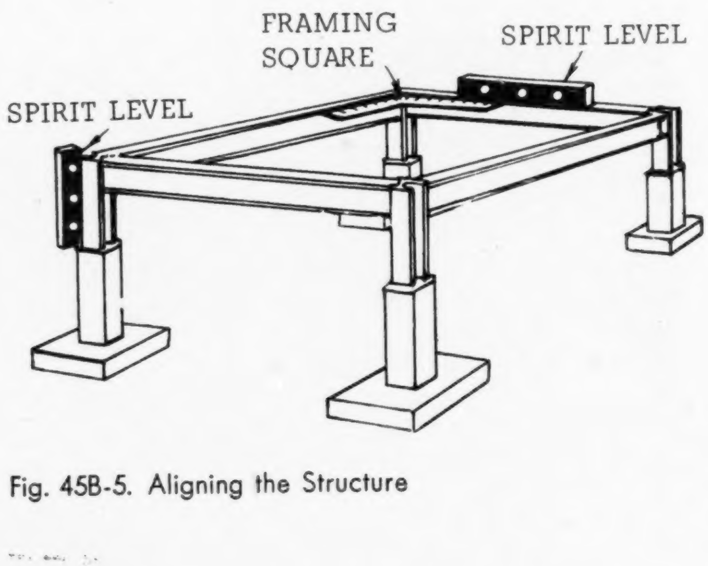


Fig. 45B-5. Aligning the Structure

4. With the columns in place, each horizontal beam can be hoisted into position by Group 2. The ends of the beam are to rest on the column support brackets.

> **Caution**
>
> The beam may fall, so care must be taken until it can be bolted to the columns.

5. After the first beam is in position, Group 3 can start the final assembly work. Bolt the beams to the columns one at a time until all four beams are fastened. Remember to tighten the nuts only finger tight.
6. Group 3 can now start the alignment procedure of the structure. The columns should be plumbed first, then the corners checked for squareness, and lastly the horizontal beams leveled.
7. After each member is aligned, a wrench can be used to make sure that the nuts are tight. (Group 3 will do this.) Check all nuts for tightness.

## Problem 5

### Objective:

*The entire class* will take the structure apart according to instruction from their teacher.

### Taking the Structure Apart

1. Your teacher will supervise the dismantling of the structure.
2. The materials, tools, and equipment are to be put in their proper storage place.
3. The last class of the day can leave the structure in place for tomorrow's activity.

**ACTIVITY 46**

# Erecting Concrete Frames

Today you are going to construct (1) a framework called a *shoring,* and (2) a form to enclose a beam in concrete. One group will build one or two forms. The remaining groups will build shoring members.

## Problem 1 (Group 1)

### Objective:

Using the instructions, illustrations, and specifications, construct a form for enclosing a beam in concrete.

**Equipment** (Group of 5)

2 claw hammers
1 try square

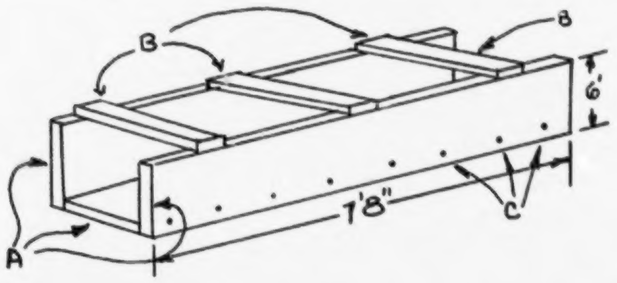
**Supplies**

See Beam Form Bill of Materials, Fig. 46-1.

### Assembling the Form

1. Get the necessary equipment and supplies.
2. Construct two forms as shown in Figs. 46-1 and 46-2.
3. "B" parts (1" x 2" x 8" boards) are spreaders. They will be installed after the forms are in place.
4. When the two forms are completed and the other groups have completed their shoring members, go to Problem 3.

Fig. 46-1. Beam Form Bill of Materials



| Qty. | Size | Materials |
|---|---|---|
| A 3p | 1" x 6" x 7'8" | Pine or equiv. |
| B 3p | 1" x 2" x 8" | Pine or equiv. |
| C 25 | 6d common nails | |

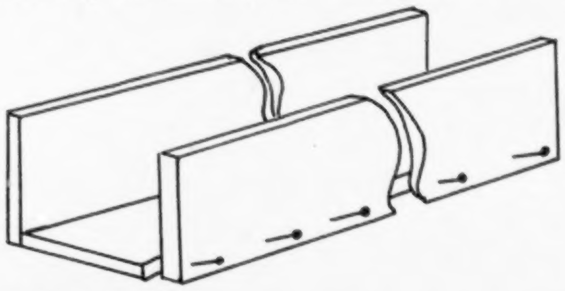


Fig. 46-2. Beam Form

## Problem 2 (Group 1, 2, 3, 4 and 5)

### Objective:

Using the instructions and illustrations, construct a shoring member for erecting concrete frames.

**Equipment** (Group of 5)

2 claw hammers
1 framing square

**Supplies**

See Shoring Bill of Materials, Fig. 46-3.

### Assembling the Shoring

1. Get the necessary equipment and supplies. See Fig. 46-3.
2. Construct two shoring members as shown in Fig. 46-4.

## Problem 3

### Objective:

Using the completed forms and shoring members, place the forms in position and

Fig. 46-3. Shoring Bill of Materials

| Qty. | Size | Materials |
|---|---|---|
| A 3 ps. | 2" x 4" x 3' | Fir or equiv. |
| B 2 ps. | 1" x 2" x 1'6" | Fir or equiv. |
| C 25 ea. | 6d common nails | |

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place the shoring members to support the form.

**Equipment** (Class)

all hammers and squares from Problems 1 and 2
1 plumb line
1 carpenter's level

**Supplies**

2 completed forms from Problem 1
8 shoring members from Problem 2
1 steel frame structure from Activity 45

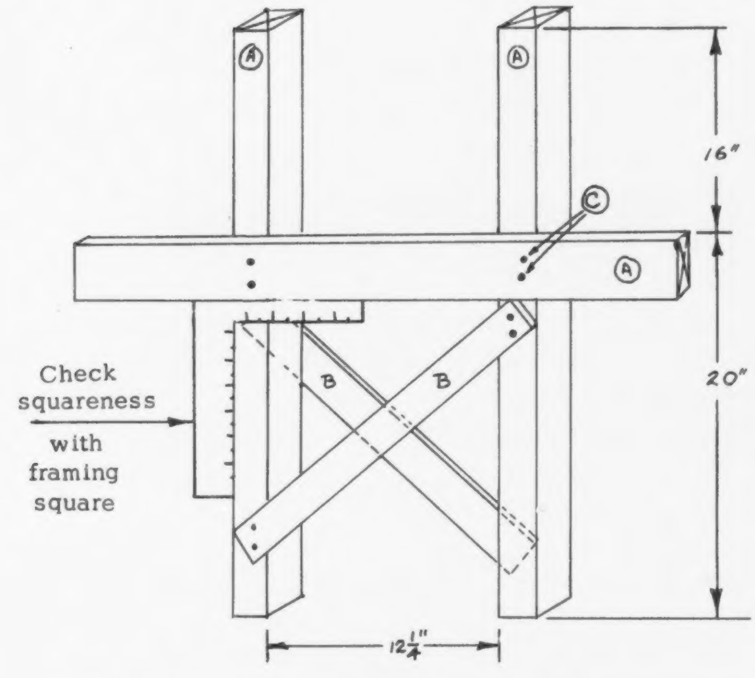

Fig. 46-4. Shoring Construction

## Placing the Form

1. Group 1 will place the forms around the steel beams erected yesterday.
2. The remaining class members will place their shoring members in the positions illustrated in Fig. 46-5.
3. Plumb and level each member to make sure it is square with the concrete footing.
4. Toenail each shoring member on both sides of the forms. CAUTION: Do not drive the nails all the way in. They should be easy to remove when taking the forms apart.
5. Group 1 should put their spreaders in place.
6. Have the instructor check the placement of the forms and shoring members.

## Problem 4

## Taking Apart

1. Remove the spreaders from the forms.
2. Remove nails that held the form to the shoring member.
3. Take apart the forms and shoring members.
4. Remove all nails and return all materials to their storage area.

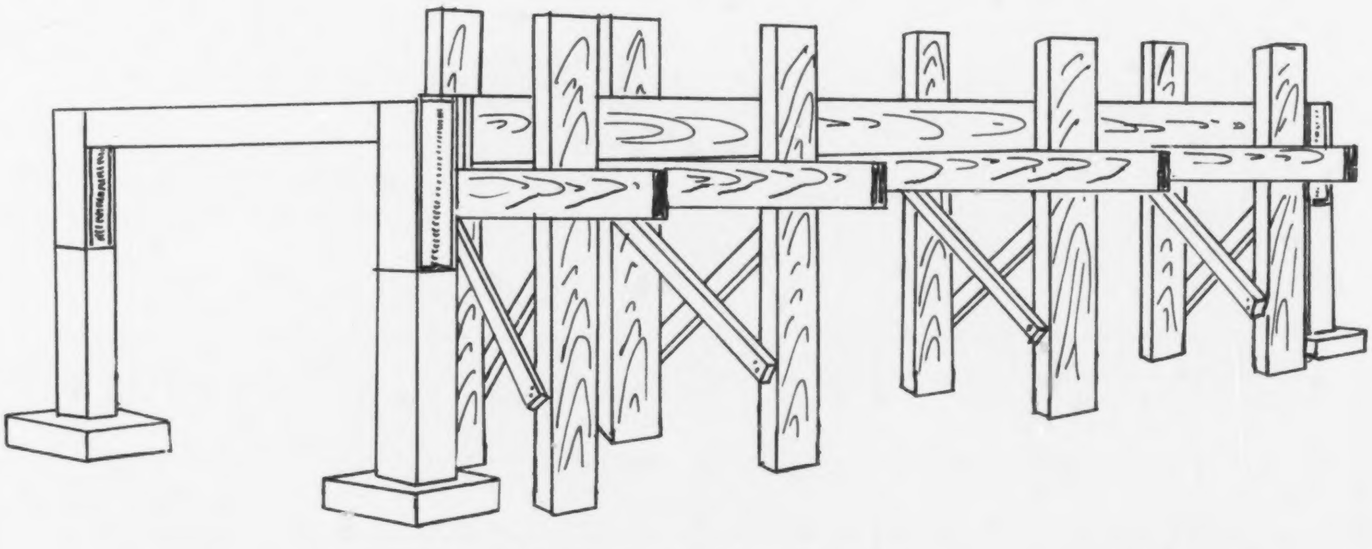

Fig. 46-5. Shoring for Concrete Frame

**ACTIVITY 47A & B**

# Building Wood Frames

Fig. 47A-1. Floor Frame Bill of Materials

| Part Name | Part No. | Qty. | Size |
|---|---|---|---|
| Floor Joist | A, B, C, D | 4 | 2″ x 6″ x 13⅞″ |
| Header | E | 1 | 2″ x 6″ x 48″ |
| Girder Plate and Sill | F | 2 | 2″ x 4″ x 48″ |
| Common Nails | | | 16d |
| Box Nails | | | 8d |
| Skids | G | 2 | 2″ x 4″ x 24″ |

During the next several days you will learn how to lay out, measure, cut, and fabricate wood frames. Today you will organize your materials and begin construction of a floor.

**Problem**

## Objective:

Using the equipment, supplies, and instructions, measure, mark and saw materials to length, and assemble the rough floor framing of a model structure.

**Equipment** (Group of 5)

| | |
|---|---|
| 5 | nail aprons |
| 1 | try square |
| 1 | pencil |
| 1 | crosscut saw |
| 2 | hammers |
| 1 | steel tape |
| 1 | framing square |

**Supplies**

See Floor Frame Bill of Materials, Fig. 47A-1.

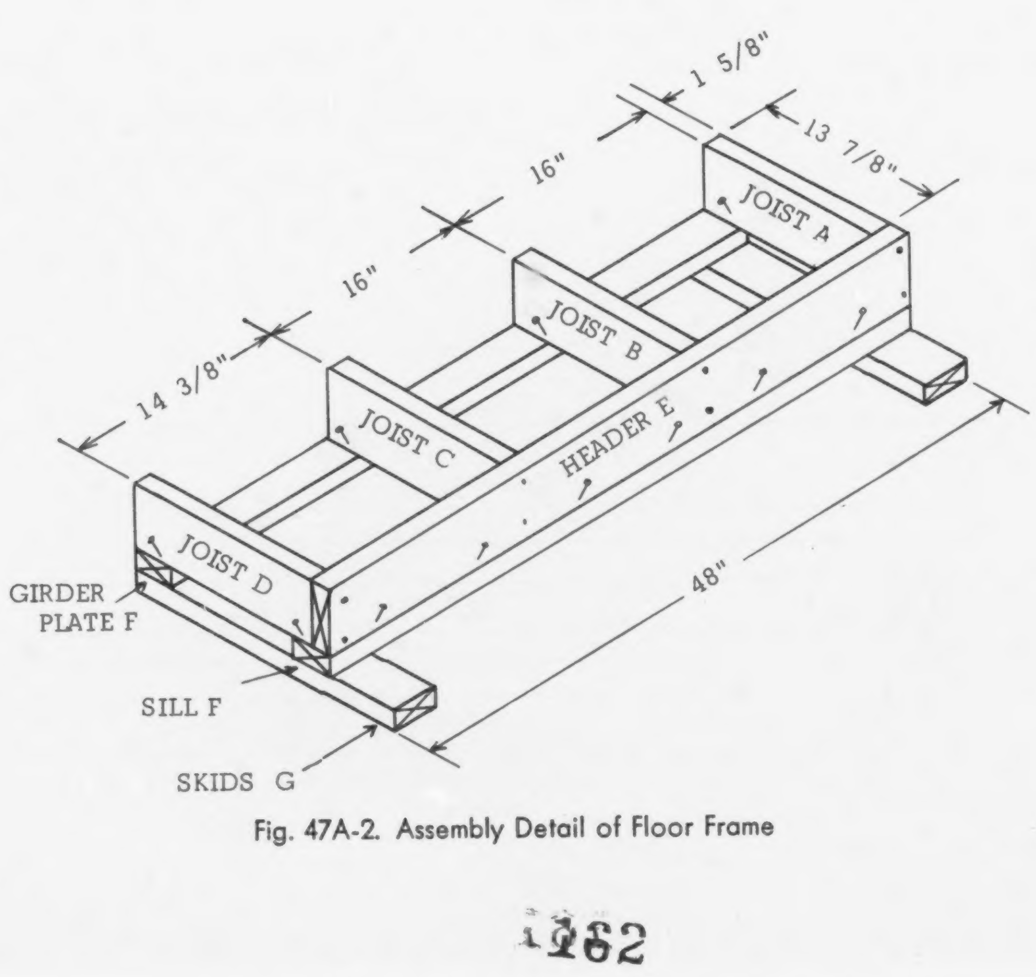
1 5/8"
13 7/8"
16"
16"
14 3/8"
JOIST A
JOIST B
JOIST C
JOIST D
HEADER E
48"
GIRDER PLATE F
SILL F
SKIDS G

Fig. 47A-2. Assembly Detail of Floor Frame

**Safety**

1. Keep fingers out of the way when sawing.
2. Keep fingers out of the way when hammering nails.

## Preparing to Work

1. Each group will get the equipment and supplies needed.
2. Examine Figs. 47A-1 and 47A-2 carefully so that you will understand how all the parts fit together.

## Measuring and Sawing

3. On the 2″ x 6″ x 10′ board, measure in 13⅞″ from one end. Mark a line across the board using a try square.
4. Double-check your measurement to be sure it is accurate. Then saw off this piece and mark it "Joist A."
5. Since four joists are needed for the floor, saw off three more joists exactly the same length as Joist A. Mark these joists "B", "C", and "D". See Fig. 47A-2.
6. Next measure 48″ and saw it off. Mark this 48″ piece "Header E." See Fig. 47A-2. Save the remaining piece of 2″ x 6″ board for tomorrow's activity.
7. On the 2″ x 4″ x 8′ board measure 48″ from one end. Saw off this piece and mark it "Girder Plate."
8. The remaining piece should also be 48″ long. If it is longer, saw off the excess so that it is exactly 48″ long. Mark this piece "Sill."

## Nailing the Header

9. Place Joist A on the floor. Place the header on top of it so that the end of the header is flush (even) with the outside surface of the joist. Nail the header to the joist using 16d nails. See Fig. 47A-3.
10. Lay out the position of the other three

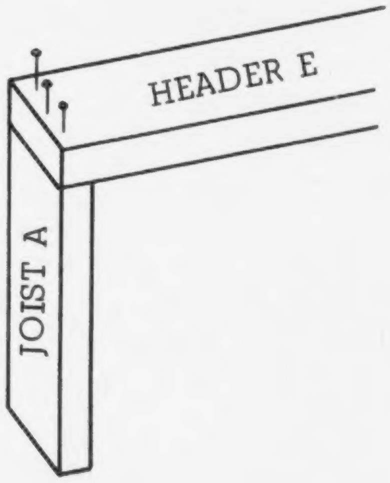

Fig. 47A-3. Nailing Headers to Joists

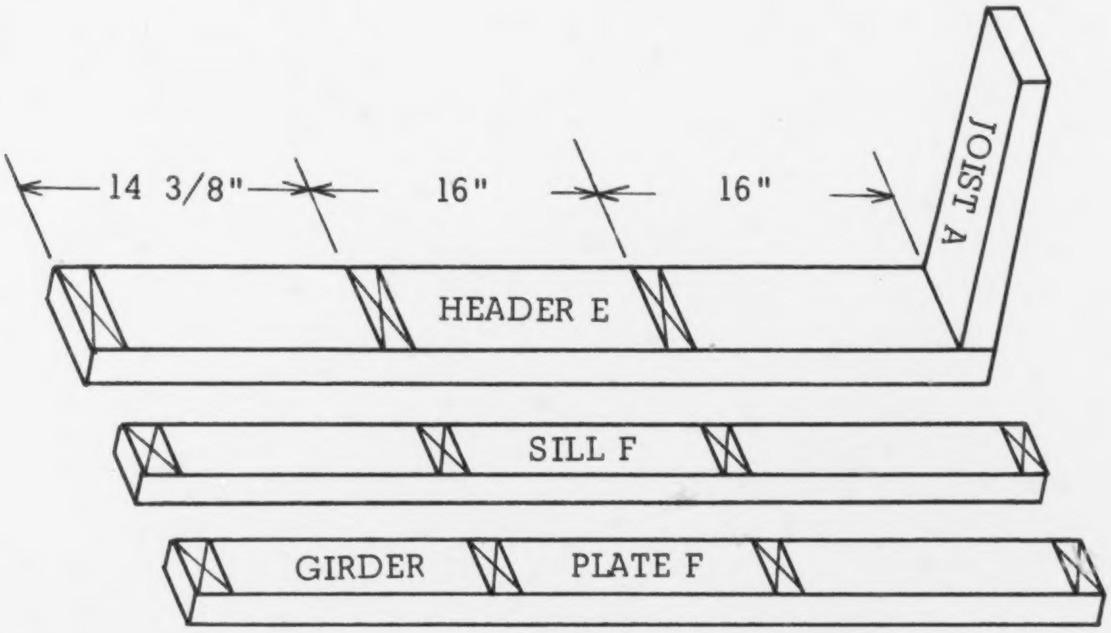

Fig. 47A-4. Layout Detail of Header, Sill, and Plate

joists on the header and the girder plates and sill. This is done by measuring 16″ from the inside surface of Joist A and marking a line at that point. Place an X on the side of the line *toward* the joist from which you just measured. Measure another 16″ from this line and mark another line. Again place an X beside the line, toward the previous mark, to show where the joists will go. See Fig. 47A-4.

11. Double-check your measurements to make sure they are accurate. Place the 2″ x 4″ girder plate and sill next to the header and mark them as shown in Fig. 47A-4. Be sure the ends of the girder plate and sill and the header are even. The lines may be laid out accurately by using a square to mark across the surface of all three boards at the same time.
12. Note that the joists are placed 16″ apart O.C. (on center) so that the actual space between floor joists is 14⅜″. See Fig. 47A-5.
13. Place the header and Joist A on top of the girder plates and sill. See Fig. 47A-2. Toenail the header and Joist A to the girder plates using 8d nails.
14. Nail Joists B, C, and D in place. See Fig. 47A-6.
15. Toenail Joists B, C, and D to the girder plates. See Fig. 47A-7.

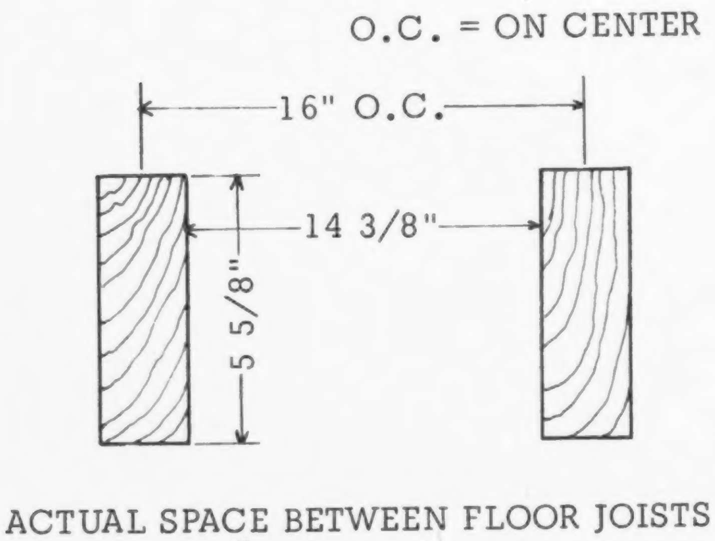

Fig. 47A-5. Joist Spacing

16. Turn the platform over and install skids and chair glides. See Fig. 47A-8.
17. Store the floor platform in an area assigned by your teacher. Return tools to their proper place and clean up your work station.

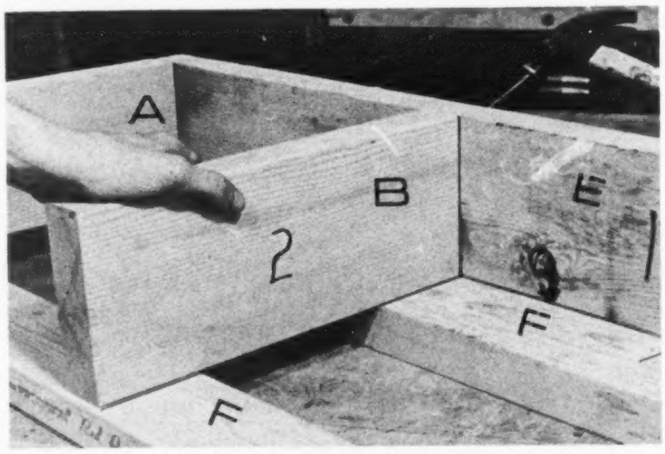

Fig. 47A-6. Face Nailing Joists in Place

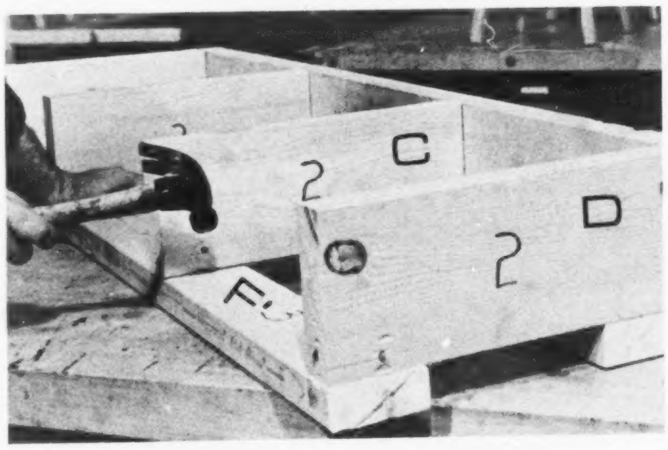

Fig. 47A-7. Toenailing Joists In Place

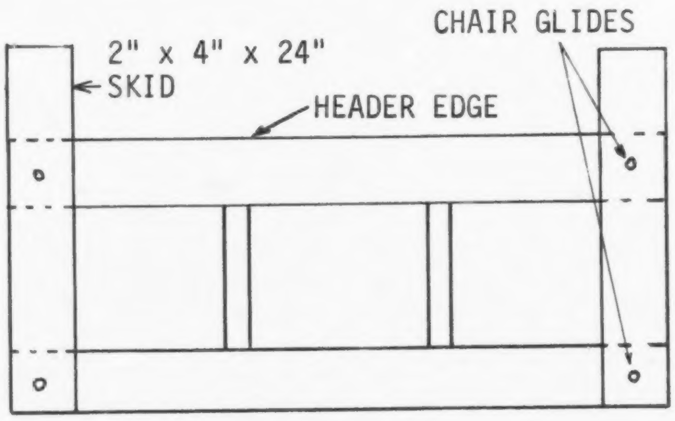

Fig. 47A-8. Skid and Chair Glide Placement

**ACTIVITY 47C**

# Building Wood Frames

Today you will construct the bridging in the floor structure and install the subfloor.

**Problem**

Fig. 47C-1. Flooring Bill of Materials

| Part Name | Qty. | Size |
|---|---|---|
| Subfloor (Plywood) | 1 | ½" x 15½" x 48" |
| Solid Bridging | 1 | 2" x 6" x 12¾" |
| Bridging | 2 | 1" x 2" x 15½" |
| Common Nails | | 16d |
| Box Nails | | 6d |

## Objective:

Given a wood floor structure, construct bridging in the floor structure and install the subfloor.

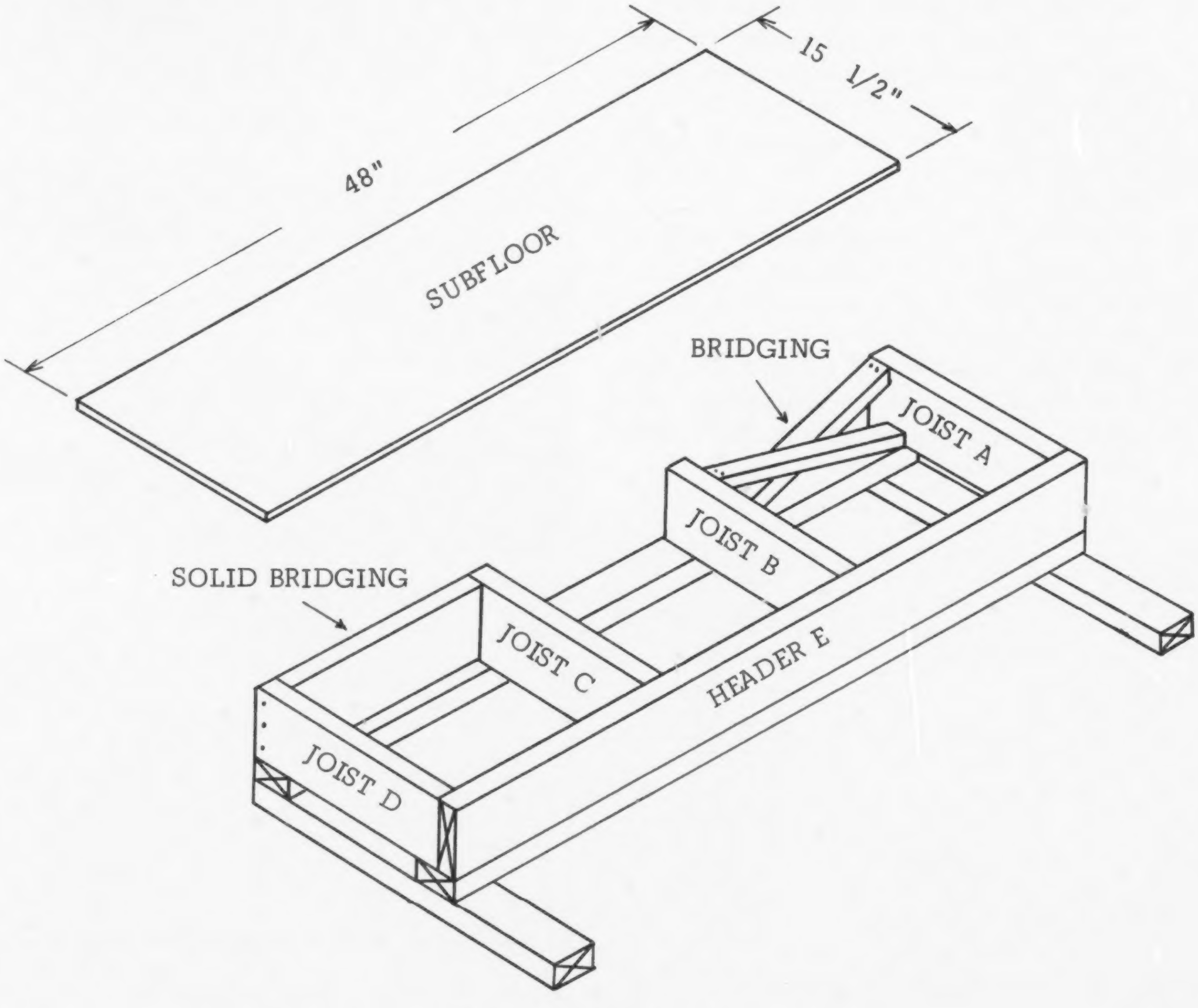
48"
15 1/2"
SUBFLOOR
BRIDGING
JOIST A
JOIST B
SOLID BRIDGING
JOIST C
HEADER E
JOIST D

Fig. 47C-2. Floor Assembly

**Equipment** (Group of 5)

5 nail aprons
1 try square
1 crosscut saw
2 claw hammers
1 pencil
1 framing square

**Supplies** (Group of 5)
See Flooring Bill of Materials, Fig. 47C-1.

> **Safety**
>
> 1. Keep fingers away from cutting edges of tools.
> 2. Keep fingers out of the way when hammering nails.

## Preparing to Work

1. Get the materials for the subfloor and bridging, and get your equipment. See Fig. 47C-1.
2. Read through this activity before beginning to work.
3. If you didn't complete the floor structure, as shown in Fig. 47A-2 of Activity 47A and B, complete it before going on with today's activity.

## Installing Bridging

4. You should have a 2″ x 6″ piece of lumber that is approximately 16″ long which was left over when you cut the header and joists in the last activity.
5. Measure the distance between the inside faces of Joists C and D. See Fig. 47C-1. This distance should be 14³⁄₈″. Saw the 2″ x 6″ piece to this length and mark it "Solid Bridging."
6. Nail the solid bridging into place with 16d nails between Joists C and D as shown in Fig. 47C-3.
7. Find the 1″ x 2″ x 36″ bridging piece. Place it at an angle between Joists A and B. See Fig. 47C-2. Mark the angle on the 1″ x 2″ piece with a pencil, and saw it off at that angle with a crosscut saw.
8. Mark the second piece of bridging the same way, and saw the angle.
9. Nail the bridging in place, as shown in Fig. 47C-4. Use 6d nails. Nail the plate ends first.

## Installing Subfloor

10. Place the ½″ x 15½″ x 48″ piece of plywood subfloor on top of the floor structure as shown in Fig. 47C-5.
11. Mark the nailing lines exactly in the center of all joists.
12. Move the subfloor into place on the floor structure. Check to see that it is flush (even) with the front face of the header

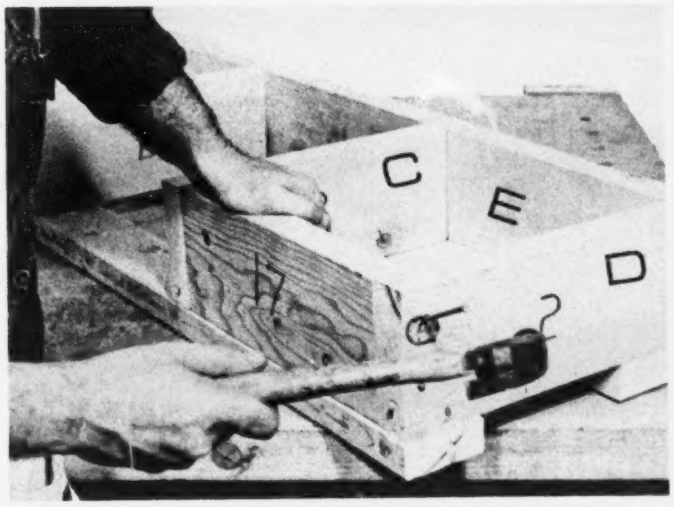

Fig. 47C-3. Nailing Solid Bridging

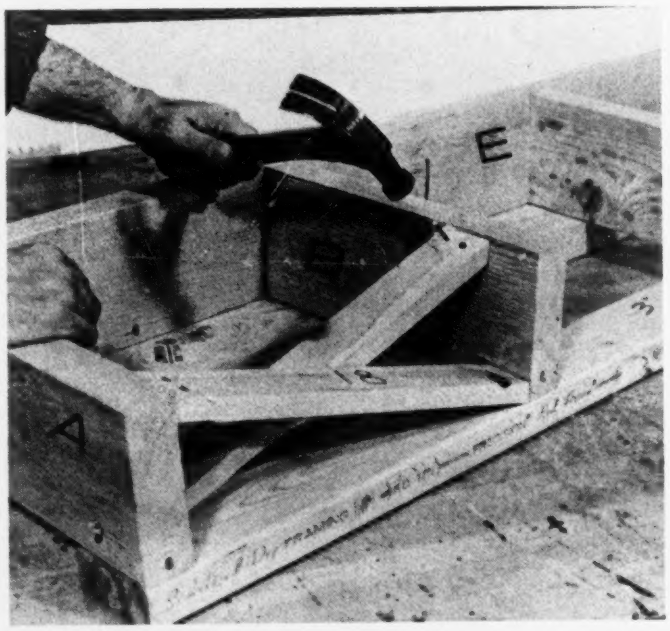

Fig. 47C-4. Nailing Cross Bridging

and flush with the outside faces of Joists A and D.

13. Check the nailing lines to be sure that they fall in the exact center of Joists B and C.
14. Nail the subfloor to the header and joists with 6d nails. Space the nails about 6" apart. Follow the nailing lines on the joists.
15. Clean up your work station, store the floor structure, and return tools to their proper place.

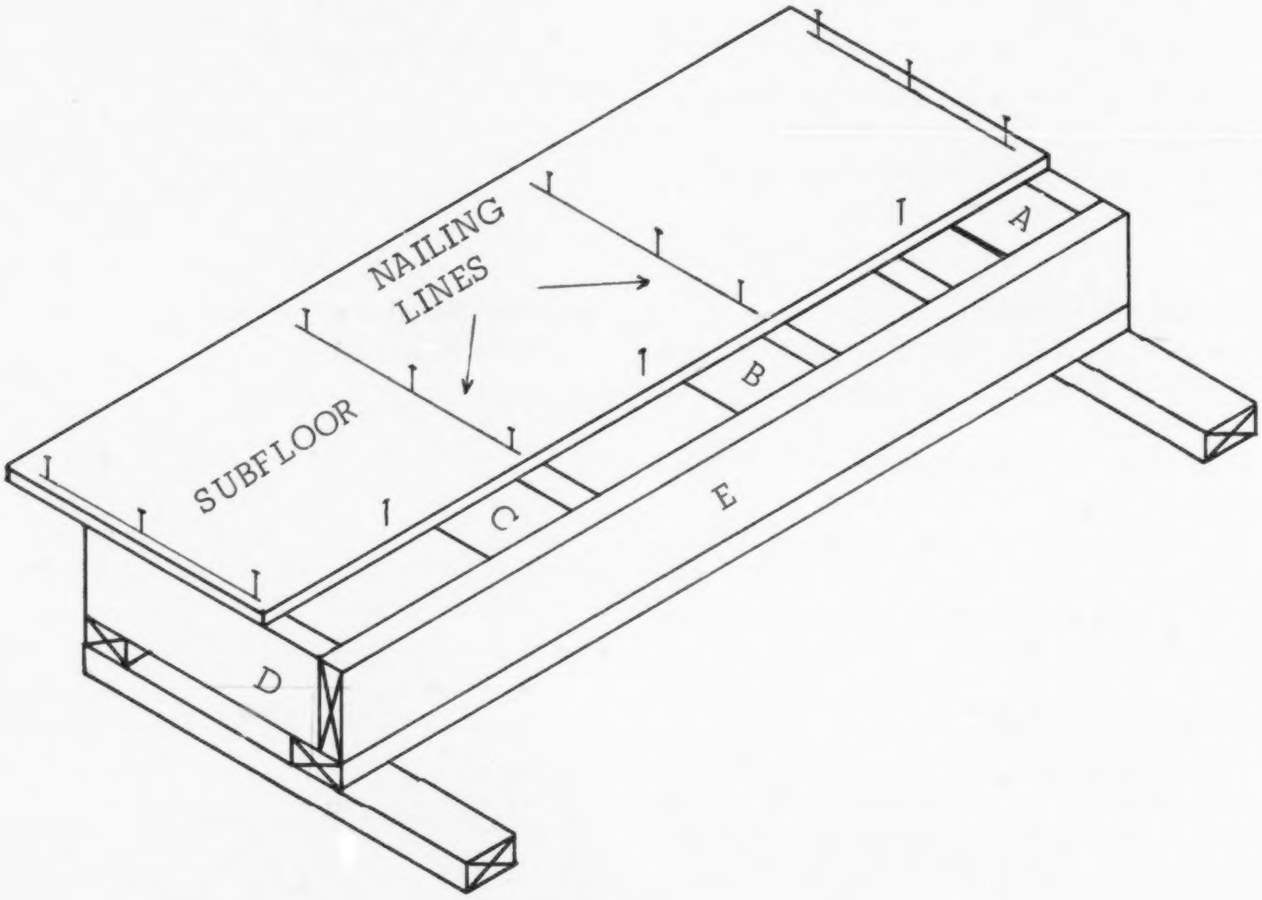

Fig. 47C-5. Assembly Detail of Wood Floor Structure

**ACTIVITY 47D**

# Building Wood Frames

**Safety**

1. Keep fingers out of the way of cutting edges.
2. Keep fingers out of the way when hammering.
3. Be careful when handling long pieces of material.

**Problem**

## Objective:

Given a wood frame floor structure, lay out the wall plates and studs, cut them to length, and assemble the wall sections.

**Equipment** (Group of 5)

| | |
|---|---|
| 5 | nail aprons |
| 2 | steel tapes |
| 2 | try squares |
| 1 | framing square |
| 2 | claw hammers |
| 2 | crosscut saws |
| 3 | pencils |

**Supplies** (Group of 5)

| | |
|---|---|
| 5 pcs. | 2″ x 4″ x 8′ lumber |
| 1 pc. | 1″ x 4″ x 36″ lumber (brace) |
| | 16d common nails |
| | 8d box nails |

## Preparing to Work

1. If you have not completed Activity 47C, do so before going on with this activity.
2. Read through today's activity.
3. Get the necessary equipment and the supplies listed in the bill of materials, and take them to your work station. See Fig. 47D-1.
4. Your group's foreman should assign two students to saw 2″ x 4″ pieces to length and three students to lay out the bottom and top plates.

## Sawing Studs to Length (Two Students)

5. Look at Fig. 47D-2. You will see that two studs are needed for Section A and five studs for Section B. (Notice that the corner of Section B is made of two studs with 2″ x 4″ blocks nailed between them.)
6. The top and bottom plates of Section B are the same length as the studs. Therefore you will have to mark and saw a total of nine 2″ x 4″ pieces to a length of 48″.
7. Mark and saw two pieces of 2″ x 4″ to a length of 11⅞″ for the top and bottom plates of Section A.
8. Mark and saw the remaining piece of 2″ x 4″ into three equal pieces. These will be used as spacers between the two studs of Section B to form the corner.

Fig. 47D-1. Wall Frame Bill of Materials

| Part Name | Part No. | Qty. | Size |
|---|---|---|---|
| Bottom Plate | A | 1 | 2″ x 4″ x 12″ |
| Top Plate | A | 1 | 2″ x 4″ x 12″ |
| Bottom Plate | B | 1 | 2″ x 4″ x 48″ |
| Top Plate | B | 1 | 2″ x 4″ x 48″ |
| Studs | | 7 | 2″ x 4″ x 43½″ |
| Brace | | 1 | 1″ x 4″ x 48″ |
| Corner Blocks | A, B, C | 3 | 2″ x 4″ x 6″ |

## Laying Out the Plates (Three Students)

9. Place the top and bottom plates for Sections A and B on the floor. Mark the locations of the studs as shown in Fig. 47D-3.

## Constructing Sections A and B

10. Construct the corner of Section B by placing three 2" x 4" blocks between two studs and nailing them together. See Fig. 47D-4.
11. Lay the studs and the top plates and bottom plates on the floor. Brace the

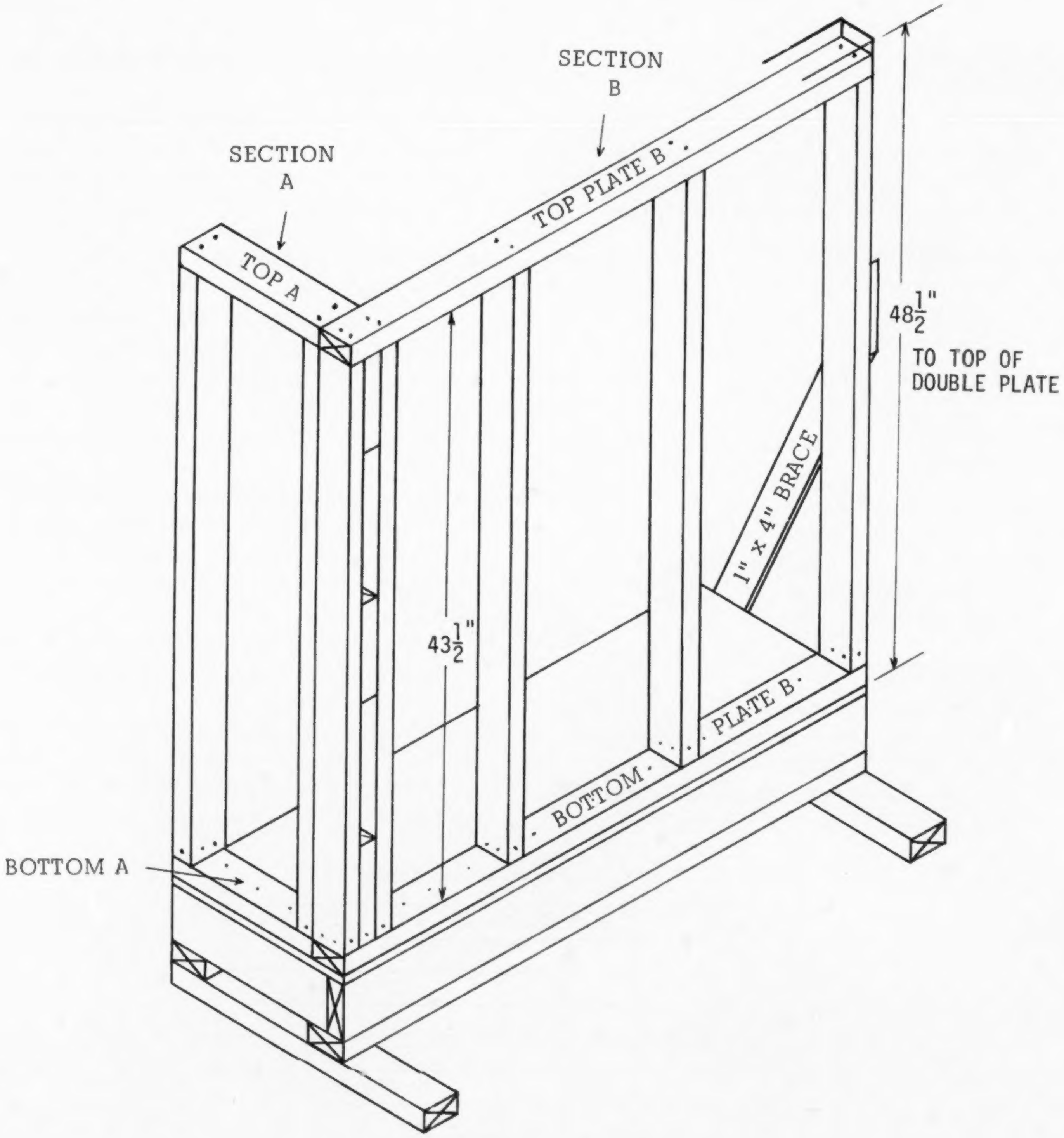
SECTION B
SECTION A
TOP PLATE B
TOP A
$48\frac{1}{2}$"
TO TOP OF DOUBLE PLATE
1" x 4" BRACE
$43\frac{1}{2}$"
PLATE B
BOTTOM
BOTTOM A

Fig. 47D-2. Detail of Framed Wall Assembly

studs against a wall. Nail the top plates to the studs as shown in Fig. 47D-5.

12. Brace the studs against a wall and nail the bottom plates the same as the top plates.
13. Raise the wall frame into position and nail the sole plate to the header. Use three or four 16d nails.
14. Brace Section B by nailing a 1" x 4" piece to the wall structure as shown in Fig. 47D-2. Use a square or level to check the plumb of the wall frame before nailing fast.

## Cleaning Up

15. Store all materials and equipment, and clean the work area.

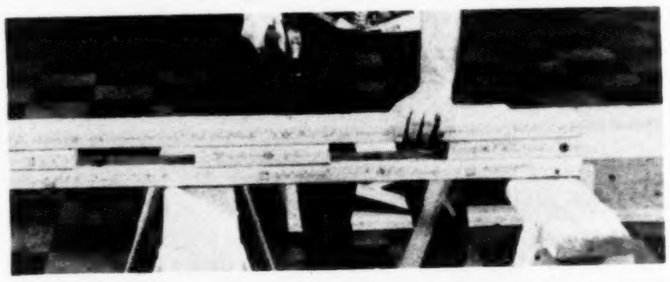

Fig. 47D-4. Nailing Blocks

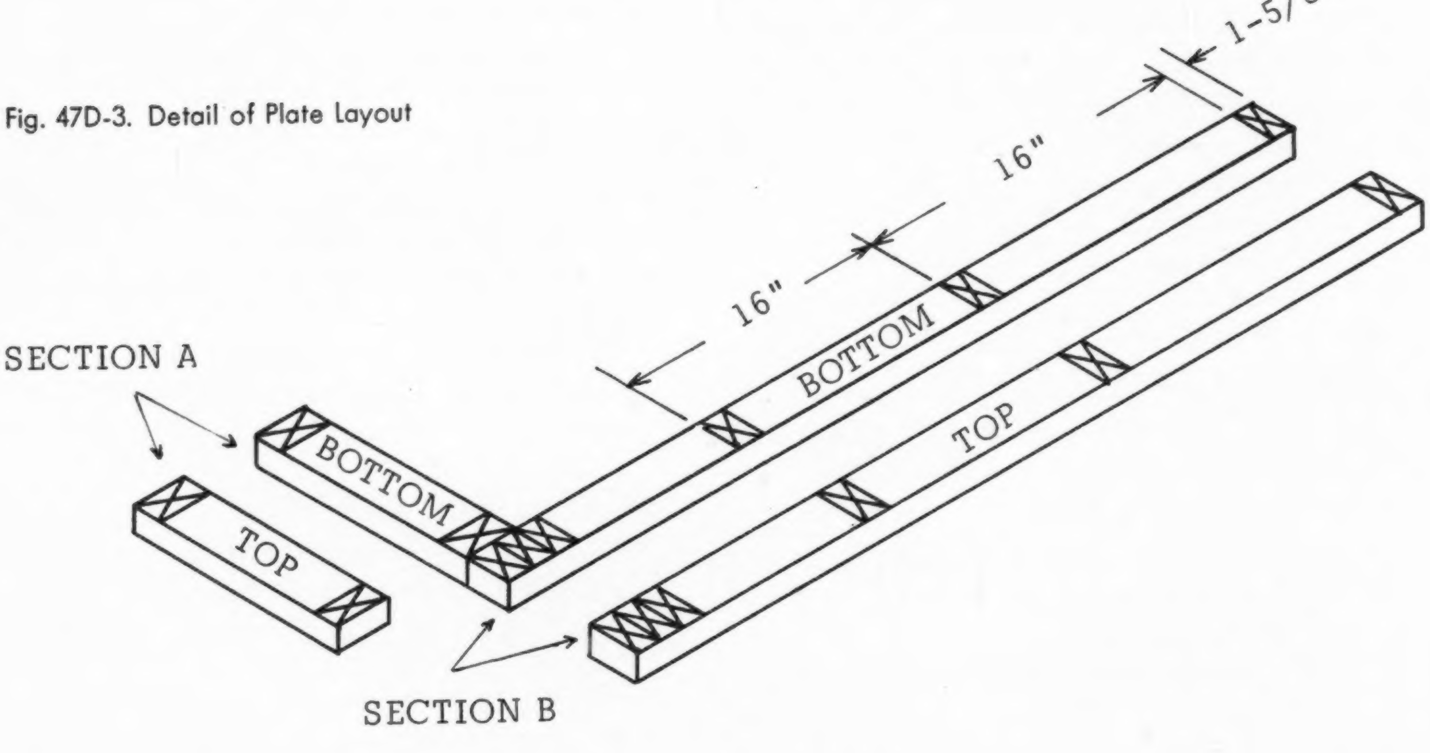
1-5/8"
16"
16"
SECTION A
BOTTOM
BOTTOM
TOP
TOP
SECTION B

Fig. 47D-3. Detail of Plate Layout

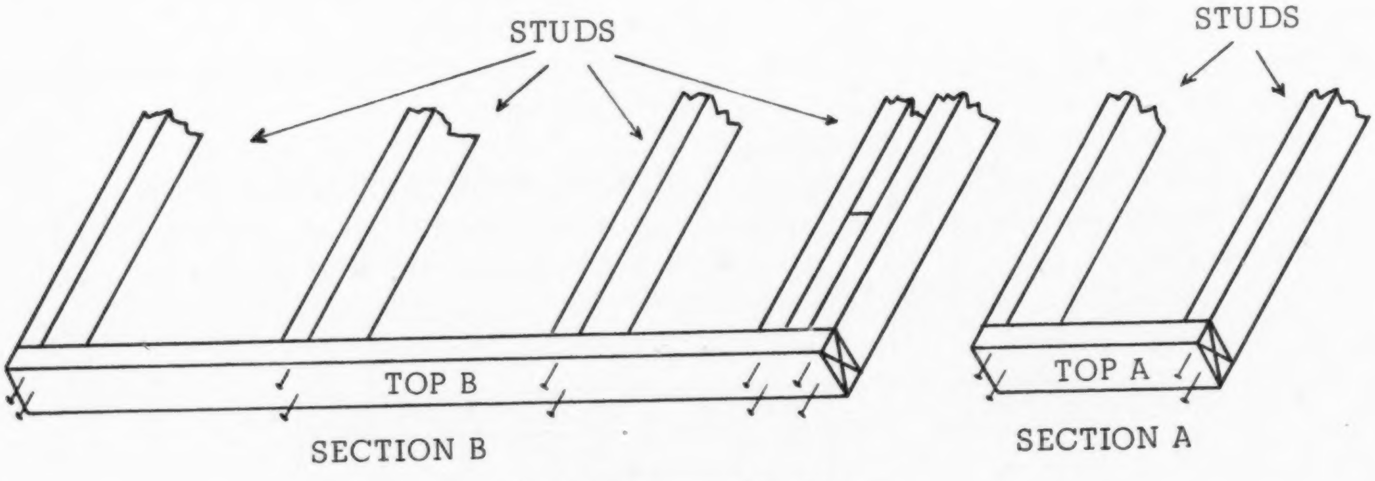
STUDS
STUDS
TOP B
TOP A
SECTION B
SECTION A

Fig. 47D-5. Detail of Stud Layout

**ACTIVITY 47E**

# Building Wood Frames

**Problem**

## Objective:

Given the wood frame structure, construct and install a window frame and a double header.

**Equipment** (Group of 5)

| | |
|---|---|
| 5 | nail aprons |
| 3 | claw hammers |
| 3 | crosscut saws |
| 1 | try square |
| 2 | pencils |
| 2 | steel tapes |

**Supplies** (Group of 5)

See Plate Bill of Material, Fig. 47E-1 and Window Bill of Materials, Fig. 47E-4

**Safety**

1. Keep fingers away from cutting edges.
2. Keep fingers out of the way when hammering nails.
3. Be careful when handling large materials.

## Preparing to Work

1. Get the needed equipment and supplies. See Figs. 47E-1 and 47E-4.
2. Examine Figs. 47E-1 and 47E-2 carefully so that you will understand how the parts are constructed before you begin working.
3. Your foreman should assign two members of your group to install the double plates which are shown in Fig. 47E-2. The other three students are to begin building the window frame.

## Sawing Stock to Length

4. Saw one of the 2″ x 4″ x 8′ pieces into three lengths, as follows:
   a. Two pieces should be 40″ long. Mark each "Window Frame."
   b. One piece should be 14⅜″ long. Mark it "Window Header."
5. Saw the other 2″ x 4″ x 8′ piece into three lengths, as follows:
   a. One piece should be 15½″ long. Mark it "Double Plate A."
   b. One piece should be 44⅜″ long. Mark it "Double Plate B."
   c. One piece should be 14⅜″ long. Mark it "Window Header."
6. Saw another piece 14⅜″ long. Mark it "Sill." See Fig. 47E-3.
7. Measure the ⅜″ plywood filler to be sure it will fit between the two 2″ x 4″ window headers. See Fig. 47E-3.

## Installing the Double Plate

8. Find the two lengths of 2″ x 4″ marked "Double Plate." Place them on top of the plates on the structure. See Fig. 47E-2.
9. Notice that the double plate of Section A overlaps the top plate of Section B. This helps to strengthen the corner of the structure.
10. Nail the double plates into place using 16d nails.

## Constructing the Window Frame

11. Lay both 40″ pieces marked "Window Frame" on the workbench.

Fig. 47E-1. Plate Bill of Materials

| Part Name | Part No. | Qty. | Size |
|---|---|---|---|
| Double Plate | A | 1 | 2″ x 4″ x 15½″ |
| Double Plate | B | 1 | 2″ x 4″ x 44⅜″ |

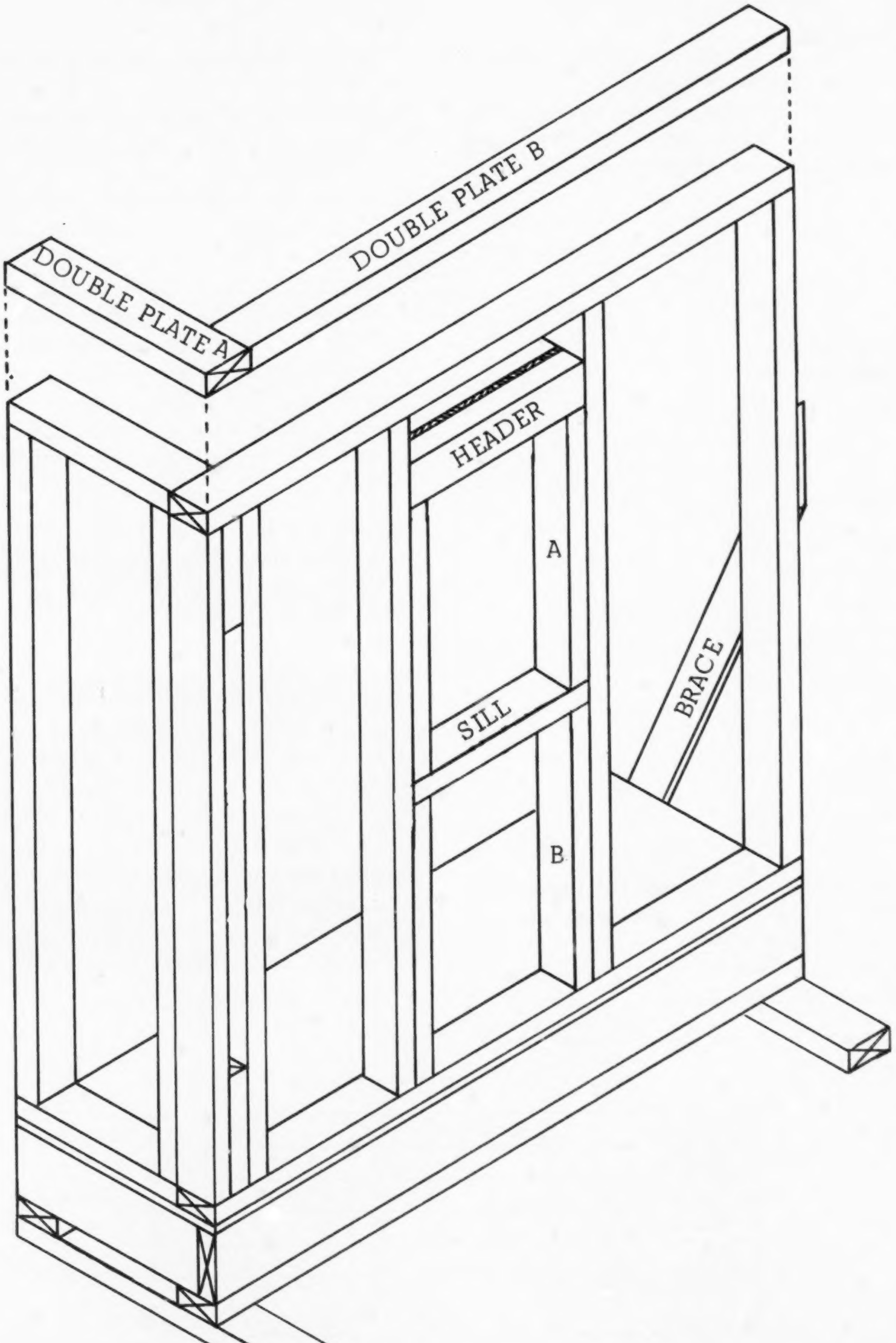
DOUBLE PLATE B
DOUBLE PLATE A
HEADER
A
SILL
BRACE
B

Fig. 47E-2. Detail of Wall Assembly

12. Measure 18″ from one end and place a mark across both pieces.
13. Saw both window frame pieces. You should now have two pieces 18″ long (mark both of them "A") and two pieces 20″ long (mark both of them "B").
14. Nail both "B" pieces to the studs in the frame structure. See Fig. 47E-2. Use 16d nails.
15. Place the window sill in place, and nail it to the "B" pieces with 8d nails.
16. Place the "A" pieces on top of the sill, and nail them in place with 16d nails.
17. Assemble the two window header pieces with the ⅜″ filler between them. Nail the assembled pieces together with 16d nails. See Fig. 47E-5.
18. Place the header above the window, and nail it securely with 16d nails. See Fig. 47E-2.

## Cleaning Up

19. Return all equipment and supplies to storage, and clean the work area.

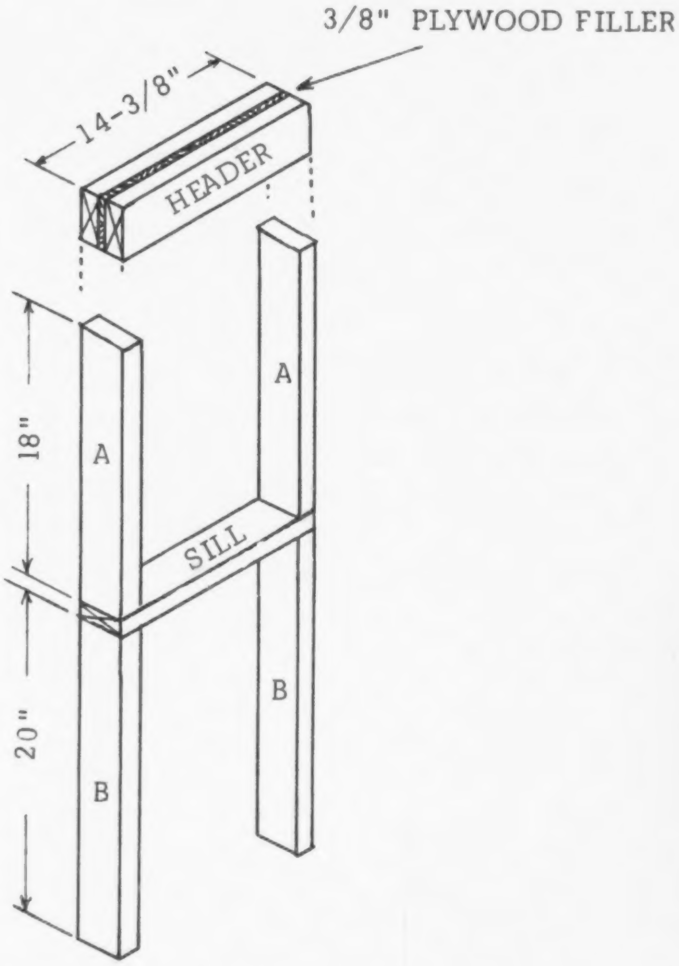

Fig. 47E-3. Window Frame Detail

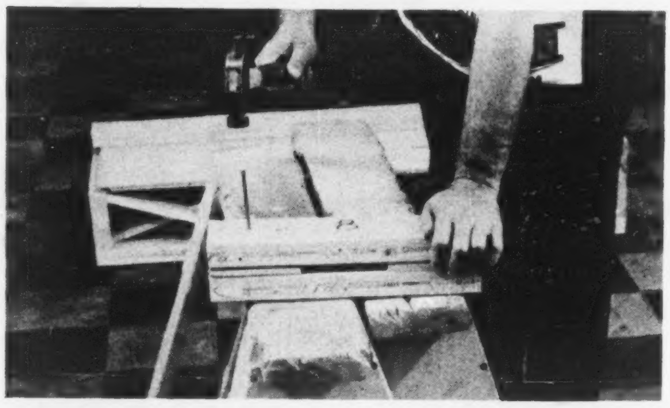

Fig. 47E-5. Nailing Header

Fig. 47E-4. Window Bill of Materials

| Part Name | Part No. | Qty. | Size |
|---|---|---|---|
| Header | | 2 | 2″ x 4″ x 14⅜″ |
| Window Frame | A | 2 | 2″ x 4″ x 18″ |
| Window Frame | B | 2 | 2″ x 4″ x 20″ |
| Sill | | 1 | 2″ x 4″ x 14⅜″ |
| Plywood Filler | | 2 | ⅜″ x 3″ x 14⅜″ plywood |

**ACTIVITY 47F-I**

# Building Wood Frames

## Problem 1

### Objective:

Given a wood frame wall and floor structure, lay out, construct, and erect the roof trusses.

**Equipment** (Group of 5, both problems)

| | |
|---|---|
| 5 | nail aprons |
| 2 | claw hammers |
| 2 | crosscut saws |
| 2 | steel tapes |
| 1 | try square |
| 1 | framing square |

**Supplies**

See Roof Truss Bill of Materials, Fig. 47F-1.

### Preparing to Work

1. Get the tools and materials needed to construct the roof trusses (Fig. 47F-1).
2. Read over the directions and figures so that you will know how to proceed with your work.
3. You may wish to divide your group so that some members begin to cut the upper chords of the roof trusses while others begin with the lower chords.

### Laying Out and Sawing Upper Chords

4. The completed roof structure is shown in Fig. 47F-2. Notice that you will need three upper chords.
5. Lay out and saw the upper chords according to Fig. 47F-2.
6. The correct angle for sawing the upper chord can be found by placing the framing square on the 2″ x 4″ piece as follows: the 6″ mark on one blade of the square should touch the lower edge and the 12″ mark on the other blade should touch the same edge. See Fig. 47F-3. Double check your measurements before you saw the 2″ x 4″ piece at that angle. Carpenters use this technique for marking the correct angle when the pitch of a roof calls for a 6″ rise for every 12″ run.
7. When you have one upper chord cut to length, use it as a pattern to mark the other three.

### Laying Out and Sawing Lower Chords

8. Figure 47F-4 shows how to lay out the correct angle of the lower chord using the framing square.
9. Once you have one lower chord sawed correctly, you may use it as a pattern to mark and saw two more.

Fig. 47F-1. Roof Truss Bill of Materials

| Part Name | Part No. | Qty. | Size |
|---|---|---|---|
| Upper Chords | A, B, C | 3 | 2″ x 4″ x 25″ |
| Lower Chords | A, B, C | 3 | 2″ x 4″ x 25″ |
| Gussets | | 4 | ½″ x 7″ x 7½″ plywood |
| Soffit | | 1 | 2″ x 2″ x 48″ |
| Ridge Board | | 1 | 1″ x 6″ x 48″ |
| Fascia | | 1 | 1″ x 6″ x 50″ |
| Braces | A & B | 2 | 2″ x 4″ x 21¾″ |
| Common Nails | | | 16d, 8d, 6d |

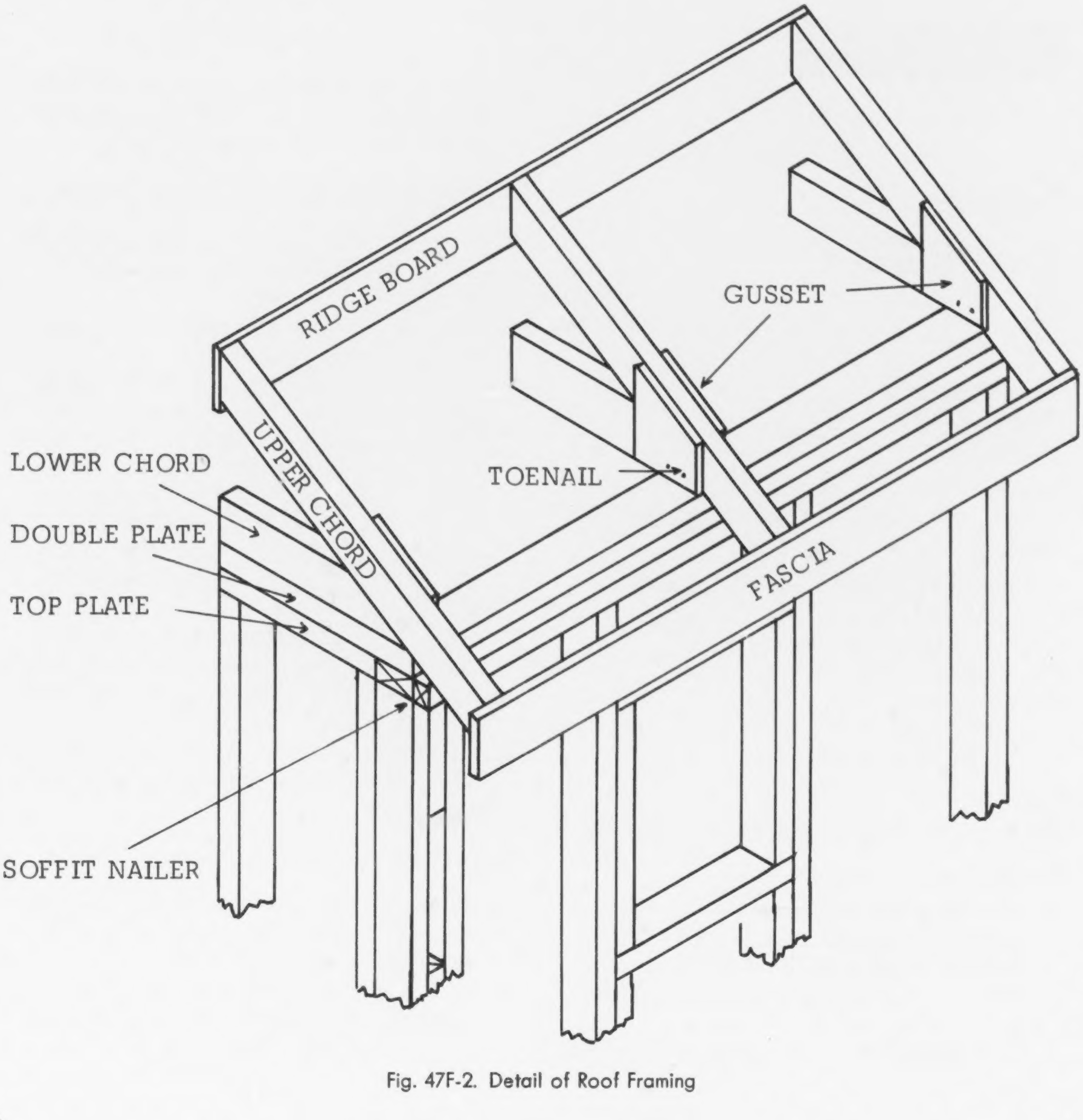
RIDGE BOARD
GUSSET
UPPER CHORD
LOWER CHORD
TOENAIL
DOUBLE PLATE
TOP PLATE
FASCIA
SOFFIT NAILER

Fig. 47F-2. Detail of Roof Framing

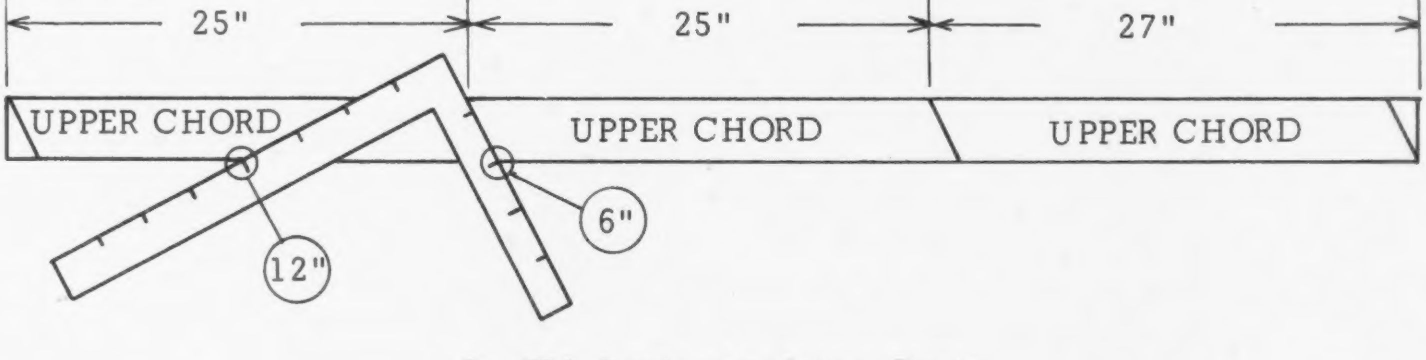
77"
25"
25"
27"
UPPER CHORD
UPPER CHORD
UPPER CHORD
12"
6"

Fig. 47F-3. Detail Layout of Upper Chords

## Nailing the Chords Together

10. When the upper and lower chords are cut to length, place one upper chord on the workbench. Place a lower chord on top, and line it up with a framing square so that the ends are flush (Fig. 47F-5).
11. Nail it in place with 8d nails. Assemble and nail the other two trusses in the same way.
12. Look at Fig. 47F-6. The gusset is a ⅜" piece of plywood used to strengthen the trusses.
13. Lay out the ⅜" x 7" x 22¼" plywood according to the dimensions given in Fig. 47F-6. Measure and mark the angles very carefully before you saw the first gusset.
14. Use the first gusset as a pattern to lay out the other three gussets.
15. Nail the gussets to the trusses with 6d nails. Notice that one truss has gussets on both sides and the other two have only one gusset. Look at Fig. 47F-2 carefully so that you will nail the gussets on the correct sides.

## Erecting the Roof Trusses

16. Place a roof truss (A or C) with one gusset flush (even) with the corner as shown in Fig. 47F-7. Toenail it to the top plate with 8d nails.
17. Set the other truss with one gusset on the opposite end and toenail it in place.
18. Nail the 1" x 6" x 48" ridge board to both end trusses. Keep the ridge board

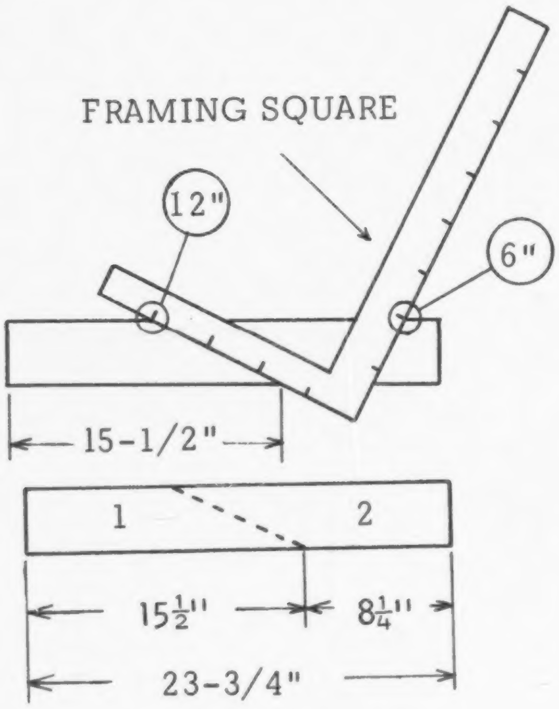

Fig. 47F-4. Detail Layout of Lower Chords

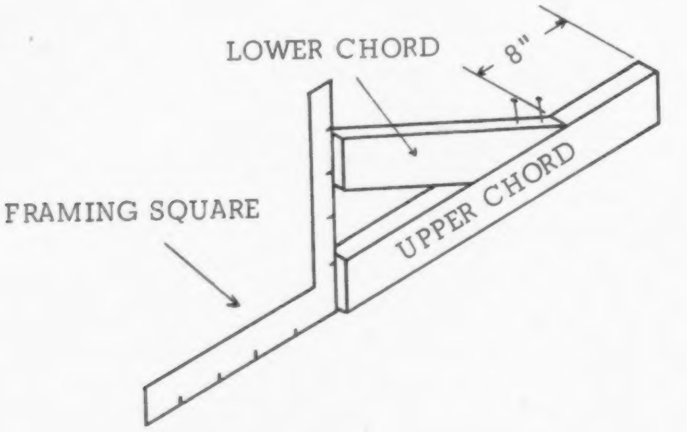

Fig. 47F-5. Detail of Truss Chord Assembly

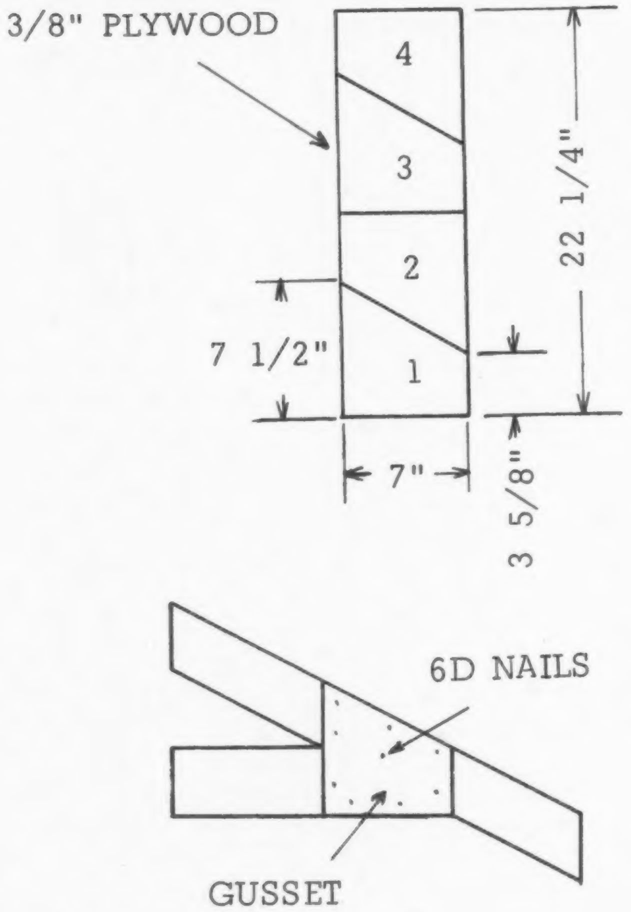

Fig. 47F-6. Detail of Gusset Layout

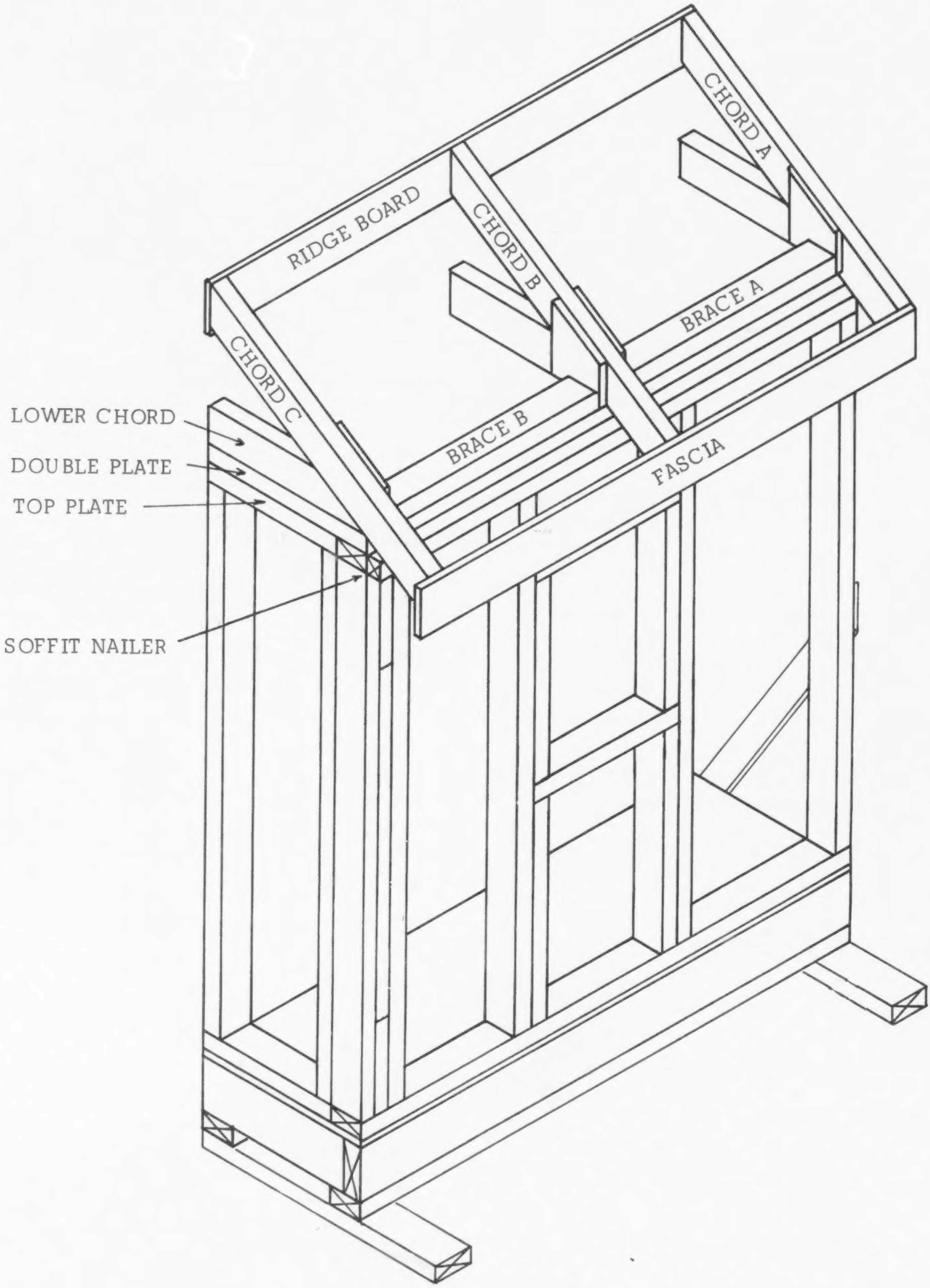
RIDGE BOARD
CHORD A
CHORD B
BRACE A
CHORD C
BRACE B
FASCIA
LOWER CHORD
DOUBLE PLATE
TOP PLATE
SOFFIT NAILER

Fig. 47F-7. Detail of Roof and Wall Assembly

even with the top of the truss. See Fig. 47F-7.

19. Use a steel tape to locate the center of the double plate. Mark the plate at this point, to locate the position of the middle truss. See Fig. 47F-7.
20. Nail the middle truss in place with 8d nails.
21. Measure the distance between trusses. It should measure 21¾″. Saw off two pieces of 2″ x 4″ board (brace A and B) to this length. Nail them in place with 16d nails to strengthen the trusses. See Fig. 47F-7.

### Laying Out and Sawing the Soffit Angle

22. Nail the 2″ x 2″ x 48″ soffit nailer to the structure. It is placed parallel with the top plate as shown in Fig. 47F-8.
23. Place a framing square against the bottom of the soffit nailer, and mark the end of the upper chord as shown in Fig. 47F-8. Saw off this small tip of the chord on all three trusses.
24. Place the fascia board flush (even) with the end of Chord A and flush with the top edges of the three trusses. This will allow it to extend 2″ beyond the end of Chord C. See Fig. 47F-7. Nail it to the chords with 6d nails.

## Problem 2

### Objective:

Given a completed wood frame structure, inspect the workmanship for accuracy and pass or reject the structure.

### Inspecting

1. Now that the wood framing is complete, you will inspect some of your classmates' work. The teacher will assign you to the structure that you are to inspect.
2. In making the inspection, each student is to work by himself. He should check the items necessary for good workmanship. See Fig. 47F-9, Inspection Check List.

### Decision Making

3. After you complete your individual inspection, meet with the other students who inspected the same structure. Compare your findings.
4. As the result of the comparison, you will *pass* or *reject* the structure. You should be able to justify the decision to the group that built the structure.
5. Staple the Inspection Check List to the frame structure that you inspected.

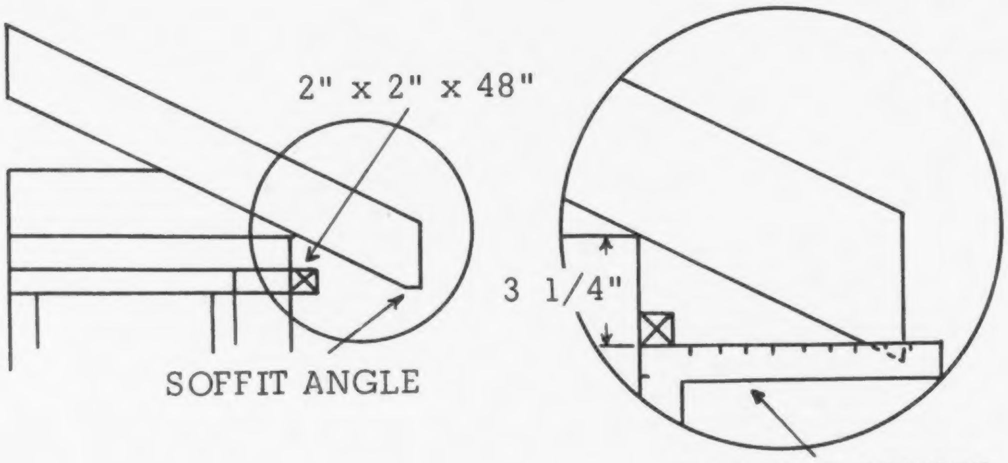

Fig. 47F-8. Laying Out the Soffit

Fig. 47F-9. Inspection Check List

| Decision: Pass______ Reject______ | Good | Fair | Poor |
|---|---|---|---|
| 1. Straightness of saw cuts | | | |
| 2. Accuracy of measurements | | | |
| 3. Squareness of inside corner | | | |
| 4. Sturdiness of structure | | | |
| 5. Nails driven properly | | | |
| 6. Enough nails used | | | |
| 7. Proper placement of parts | | | |
| 8. Proper fit of parts | | | |
| 9. General overall appearance | | | |
| 10. Other factors (                    ) | | | |
| Signature____________________ | | | |

## Activity Notes and Records

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